



## Pueblo del Arroyo Erosion Control Project Environmental Assessment



**Chaco Culture**  
National Historical Park  
New Mexico

**February, 2005**

## **Environmental Assessment**

### **Pueblo del Arroyo Erosion Control Project**

#### **CHACO CULTURE NATIONAL HISTORICAL PARK NEW MEXICO**

## **Summary**

Chaco Culture National Historical Park is the site of several approximately 1000-year old great house structures, remains of a North American pre-historic civilization known in modern times as the Ancestral Puebloans. One of these great houses, Pueblo del Arroyo, is located in the middle of the floor of Chaco Canyon, on the north side of Chaco Wash (See Figure 1-1). Because of its location immediately adjacent to the recently-formed (approximately 100 years ago), deeply incised arroyo, Pueblo del Arroyo appears to be at risk of damage from erosion caused by sporadic, extreme flood events within Chaco Wash. At present, the south walls of Pueblo del Arroyo are within ten feet of the north edge of the arroyo. Further, a cut-off chute has developed immediately adjacent to the structure at its southwest corner (see Figure 1-2 and 1-6). This chute will convey floodwaters associated with a 50-year (or longer frequency) flood event and likely undergo additional erosion, further reducing the stability of the arroyo wall. Conservative modeling of runoff associated with a theoretical extreme storm event for the region – the 100-year, 1-hour storm – predicts a peak flow that almost entirely inundates the 150-feet wide, 16- to 20-feet deep arroyo.

The proposed action consists of implementing an erosion control measure that will reduce the risk of damage to Pueblo del Arroyo that could occur during flash-flooding in the arroyo. Three erosion control measures that would provide varying degrees of protection of the arroyo wall from flow-caused erosion have been analyzed in the preparation of this EA. These are:

1. **Alternative 1: No Action.** The No-action alternative consists of letting natural processes take their course. It is assumed that a large storm (of 50- to 100-year frequency) will eventually result in high-stage runoff with the potential to cause damage at the Pueblo del Arroyo site through erosion of the arroyo wall. Since the present phase of the arroyo cycle is characterized by floodplain aggradation (sediment accumulation), flood stage elevations increase for a given flood with the passage of time. Under current conditions, peak runoff from the 100-year (1-hour) storm is predicted to almost completely fill the 150-feet wide, 16- to 20-feet deep arroyo for a period of approximately ½ hour. While large woody vegetation that is present appears to limit erosion of the



- arroyo walls during flooding, such vegetation is mostly absent along the south side of Pueblo del Arroyo. A cut-off chute has developed during the period 1880-1910 immediately adjacent to the structure at its southwest corner (see Photograph 2).
2. Alternative 2: The NPS Preferred Alternative. A combination approach involving limited filling of the cut-off chute and along the arroyo wall, to be stabilized using cable-rail fencing along the base of the wall (see Figure 2-1). Also, Alternative 2 would include re-establishment and enhancement of stabilizing vegetation on the new fill slope and in disturbed areas on the arroyo floodplain adjacent to Pueblo del Arroyo. A shallow temporary (2 to 5 years) irrigation well would be used to ensure the re-vegetation efforts are successful. Alternative 2 is also the environmentally preferred alternative.
  3. Alternative 3: Installation of intermittent erosion control structures such as cable-rail jetties and fences on the arroyo floor/floodplain and adjacent to the arroyo wall for stabilization and also to increase sedimentation by reducing flow velocities (see Figure 2-2).

This Environmental Assessment has been prepared in compliance with the National Environmental Policy Act (NEPA) to provide the decision-making framework that

- 1) analyzes a reasonable range of alternatives to meet the objectives of the proposal,
- 2) evaluates potential issues and impacts to Chaco Culture National Historical Park resources and values, and
- 3) identifies mitigation measures to lessen the degree of these impacts.

Resource topics that have been addressed in this EA include floodplains/Waters of the U.S., vegetation, archaeological resources, historic structures/cultural landscapes, ethnographic resources, and visitor use/experience. Topics dismissed from consideration due to minor or negligible impact include air quality, water quality, wildlife including threatened, endangered, and sensitive species, wetlands, prime and unique farmlands, environmental justice, regional economy, concessions, lightscape management, and visitor safety. A summary of the determinations of effect for each resource topic considered for each alternative is presented in Table ES-1.

### **Public Comment**

If you wish to comment on this environmental Assessment, you may mail comments to the name and address below. This Environmental Assessment will be on public review for 30 days. Please note that names and addresses of people who comment become part of the public record. If you wish us to withhold your name and/or address, you must state this prominently at the beginning of your comment. We will make all submissions from organizations, businesses and from individuals identifying themselves as representatives or officials of organizations or businesses available for public inspection in their entirety.

Please send any comments on this Environmental Assessment to:

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Or

E-mail: [chcu\\_pdacomments@nps.gov](mailto:chcu_pdacomments@nps.gov)  
E-mail Subject line: "Pueblo del Arroyo Erosion Control EA"

Cover Photo: Chaco Wash upstream from Pueblo del Arroyo during a flood event in summer 2004.  
This flood stage within the arroyo is estimated to be commensurate with a 25-year storm event.

**TABLE ES-1  
SUMMARY OF EFFECTS FOR ALTERNATIVES CONSIDERED**

<b>Environmental Resource</b>	<b>Alternative 1 No Action</b>	<b>Preferred Alternative (Alternative 2)</b>	<b>Alternative 3 Intermittent Structures</b>
<b>Soils</b>	Negligible effect.	Negligible Effect. Mitigation consisting of re-planting of grasses with mulch matting would be required. Approved fill free of noxious weeds would be required.	Negligible Effect. Mitigation consisting of re-planting of grasses with mulch matting would be required.
<b>Floodplains/ Waters of the U.S.</b>	Negligible effect.	Negligible effect. Minimal local effect on flood-stage streamflow. Local floodplain modification would not alter floodplain resources or values.	<b><i>Negligible-to-minor adverse effect</i></b> on floodplain values and flood-stage streamflow; local flow velocity increases dissipate immediately downstream.
<b>Vegetation</b>	Negligible effect.	Negligible effect. Local disturbances mitigated through re-seeding and replanting.	Negligible effect. Local disturbances mitigated through re-seeding and replanting.



**TABLE ES-1 (continued)**  
**SUMMARY OF EFFECTS FOR ALTERNATIVES CONSIDERED**

Environmental Resource	Alternative 1 No Action	Preferred Alternative (Alternative 2)	Alternative 3 Intermittent Structures
<b>Archaeological Resources</b>	<i>Indirect moderate adverse effect</i> under NEPA criteria. Several sites are present in the arroyo walls and flood-stage flows may be expected to cause local erosion and damage; <b>Adverse effect</b> under Section 106 to archaeological sites in the project area.	<i>Long-term direct minor beneficial effect</i> under NEPA criteria. Placement of fill along the arroyo wall to half-height would stabilize the arroyo wall while still allowing a degree of study to be performed at the small cultural sites; <b>No adverse effect</b> under Section 106.	<i>Indirect long-term minor beneficial effect</i> under NEPA criteria – jetty fields would reduce risk of erosion, but protection would not be as great as under preferred alternative; <b>No adverse effect</b> under Section 106
<b>Historic Structures/ Cultural Landscapes</b>	<i>Indirect long-term moderate adverse effect</i> under NEPA criteria. Flood-related erosion would likely eventually lead to damage to great house; <b>Adverse effect</b> under Section 106.	<i>Direct minor beneficial effect</i> under NEPA criteria. Stabilization would achieve preservation of great house; <b>No adverse effect</b> under Section 106.	<i>Indirect minor beneficial effect</i> in the form of preservation but to lesser degree than Preferred Alternative, with minor adverse effect on historic feeling; <b>No adverse effect</b> under Section 106.
<b>Ethnographic Resources</b>	<i>Indirect minor to moderate adverse effect</i> under NEPA criteria due to eventual flood-related damage to traditional cultural resource; <b>Adverse effect</b> under Section 106.	<i>Direct long-term minor beneficial effect</i> (preservation of traditional cultural resource) under NEPA criteria; <b>No adverse effect</b> under Section 106 criteria.	<i>Indirect long-term minor beneficial effect</i> through reduction of erosion risk; <b>No adverse effect</b> under Section 106 criteria.
<b>Visitor Use/Natural Soundscape</b>	<i>Minor long-term adverse effect</i> in the event of flood-related damage to Pueblo del Arroyo, leading to reduction in visitor use.	<i>Minor long-term beneficial effect</i> through continued use of site, temporary adverse effects are negligible, during construction and re-vegetation.	<i>Minor long-term beneficial effect</i> through continued use of site, temporary adverse effects are negligible, during construction.

## TABLE OF CONTENTS

Summary .....	ES-1
List of Acronyms .....	iii
1.0 Purpose And Need .....	1
1.1 Introduction .....	1
1.2 Background.....	1
1.3 Purpose .....	3
1.4 Need .....	3
1.5 Project Objectives .....	4
1.6 Project Scoping .....	4
1.7 Erosion Control Issue Topics Retained For Consideration.....	8
1.8 Erosion Control Issue Topics Dismissed From Further Consideration .....	9
2.0 Alternatives Considered.....	14
2.1 Alternative 1: No-Action Alternative .....	14
2.2 Alternative 2: NPS Preferred Alternative .....	14
2.3 Alternative 3: Intermittent Erosion Control Structures .....	15
2.4 Alternatives Dismissed From Further Consideration.....	16
2.5 Mitigation Measures .....	18
2.6 Environmentally Preferred Alternative .....	19
3.0 Environmental Consequences .....	19
3.1 Natural Resources.....	25
3.1.1 Soils .....	27
3.1.2 Floodplains/Waters of the U.S. ....	30
3.1.3 Vegetation .....	35
3.2 Cultural Resources .....	39
3.2.1 Methodology for Cultural Resource Effects Determinations.....	40
3.2.2 Regulation and Policies.....	42
3.2.3 Archaeological Resources.....	45
3.2.3 Historic Structures/Cultural Landscapes .....	48
3.2.4 Ethnographic Resources.....	56
3.3 Visitor Experience, Understanding, And Appreciation.....	60
3.3.1 Affected Environment .....	60
3.3.2 Methodology .....	60
3.3.3 Regulation and Policies.....	61
3.3.4 Visitor Experience Impacts of the No-Action Alternative.....	62
3.3.5 Visitor Experience Impacts of the Preferred Alternative .....	62
3.3.6 Visitor Use Impacts of Alternative 3 .....	64
4.0 Consultation/Coordination .....	65
List of Contributors.....	65
5.0 References.....	66
Glossary .....	71

### GRAPHICS – Photographs and Figures

### APPENDIX A: CULTURAL RESOURCES DOCUMENTATION

NHPA/SECTION 106 SHPO Review Document for Erosion Control Alternatives  
 At Pueblo del Arroyo

## LIST OF FIGURES

Figure No.	Title
1-1	Topographic Map of Site Area
1-2	Site Area Detail
1-3	Chaco Wash Drainage Basin Map
1-4	Historical Aerial Photograph No. 1
1-5	Historical Aerial Photograph No. 2
1-6	Present-Day (2000) Aerial Photograph
1-7	Minimum Safe Distances – Miscellaneous Construction Machinery
1-8	Minimum Safe Distances – Construction Vehicles
2-1	Preferred Alternative Construction Plan Detail
2-2	Alternative 3 – Intermittent Structures Construction Plan Detail

## LIST OF PHOTOGRAPHS/IMAGES

Photograph No.	Title
1	Pueblo del Arroyo – South Side View
2	Chute at Southwest edge of Pueblo del Arroyo
3	Arroyo Wall Illustrating Effects of Undercutting
4	Pueblo del Arroyo – Pueblo Bonito Overlook View

## TABLES

Table	Title
ES-1	Summary of Effects for Alternatives Considered
3-1	Natural Resource Effect Definitions
3-2	NEPA And Section 106 (NHPA) Cultural Resources Effects Definitions
3-3	Visitor Experience Effect Definitions



## **List of Acronyms**

ACHP	Advisory Council on Historic Preservation
BOR	U.S. Bureau of Reclamation
CFR	Code of Federal Regulations
CCNHP	Chaco Culture National Historical Park
CEQ	Council on Environmental Quality
CWA	Clean Water Act; the Federal Water Pollution Control Act
ESA	Endangered Species Act
EA	Environmental Assessment
GMP	General Management Plan
GIS	Geographical Information System
GPS	Global Positioning System
IMR	Intermountain Region of NPS
NEPA	National Environmental Policy Act
NHPA	National Historical Preservation Act
NPS	National Park Service
NRHP	National Register of Historic Properties
NMAC	New Mexico Administrative Code
NMAQB	New Mexico Air Quality Bureau
NMSA	New Mexico Statutes Annotated
P.L.	Public Law
RMP	Resource Management Plan
T & E	Threatened and Endangered (Species)
SHPO	State Historic Preservation Office
TCP	Traditional Cultural Property
UNESCO	United Nations Educational, Scientific and Cultural Organization
U.S.	United States
USACE	United States Army Corps of Engineers
USC	United States Code
USEPA	U.S. Environmental Protection Agency
USGS	United States Geological Survey

# 1.0 Purpose And Need

## 1.1 Introduction

Chaco Culture National Historical Park (CCNHP) is located in northwest New Mexico, approximately 60 miles south of the city of Farmington. The park was originally designated Chaco Canyon National Monument in 1907. The passage of the Organic Act in 1916 created the National Park Service, within which the monument was included. The Organic Act set forth the NPS mission to preserve unimpaired the features of each park and provide for the enjoyment of these features by future generations. In 1980 the monument was enlarged to its current size of 34,000 acres and designated a National Historical Park. The park was added to the UNESCO list of World Heritage Sites in 1987. The park contains thousands of archaeological sites, material evidence of a culture known collectively in modern times as the Ancestral Puebloans (also sometimes referred to as the “Anasazi”, although use of this term is discouraged), who lived in Chaco Canyon during the period from circa 800 to 1200 A.D. The great house structures, remains of multi-story buildings constructed during this period, are among the most easily observable and perhaps the most impressive cultural resources left by the Chacoan people.

The proposed action consists of implementing erosion control measures that would reduce the risk of damage to Pueblo del Arroyo from erosion of the arroyo wall during massive flash flood events that sometimes occur within the arroyo. Pueblo del Arroyo is a prominent great house site in the park, located at the midpoint of the Visitor Loop Road. The purpose of this Environmental Assessment (EA) is to examine the impacts associated with implementing the proposed erosion control action. This EA has been prepared in accordance with the National Environmental Policy Act (NEPA) of 1969, regulations of the Council on Environmental Quality (CEQ) (40 CFR 1500-1508), and the National Park Service (NPS) Director’s Order No. 12 (DO-12, NPS, 2001b)) (*Conservation Planning, Environmental Impact Analysis, and Decision-Making*), NPS-28 (Cultural Resource Management Guideline), and NPS Management Policies (2001a). Key concept terms related to the project are defined in the glossary accompanying this EA.

## 1.2 Background

Erosion of the Chaco Wash vertical arroyo walls has been, since the early 1900s, of concern to the NPS. The wash is dry for many months of the year but when significant precipitation occurs, the wash is subject to flash flooding, which can

vary in intensity from a few feet of water in the central channel to an “arroyo-full” condition. The estimated 100-year flood would result in a just-below arroyo-full condition near Pueblo del Arroyo (BOR, 1998). This estimate is based on modeled discharge and flow velocity values (Simons et al., 1982; RMC, 2002a).

The National Park Service (NPS) was created in 1916 with the passage of the NPS “Organic Act” (16 U.S.C. Secs. 1-4). The purpose of the parks and monuments created under the authority of the Act is to “conserve the scenery and the natural and historic objects and the wildlife therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations.” The NPS’ mandate to preserve resources for future generations must be implemented while also complying with NPS Management Policies (2001a) that direct against causing adverse affects to archaeological resources and the landscape, or detracting from optimal public enjoyment. The proposed action must achieve the objectives while avoiding undue adverse impacts to other resources.

With regard to erosion threats to archaeological resources, NPS Management Policies (2001a) indicate that “Archeological resources subject to erosion, slumping, subsidence, or other natural deterioration will be stabilized using the least intrusive and destructive methods. The methods used will protect natural resources and processes to the maximum extent feasible. Stabilization will occur only after sufficient research demonstrates the likely success of the proposed stabilizing action, and after existing conditions are documented.” (NPS Management Policies, 2001a).

Superintendent’s yearly summaries have documented large flows in terms of stage, e.g., a 7.5-foot rise in stage the first four days in August 1936, heavy floods up to 8 feet stage several times in the summer of 1955, and reportedly, stages up to 21 feet as of 1969 (Simons et al., 1982 pages 5.27 and 5.45). Runoff modeling has predicted an almost fully flooded arroyo to be associated with a theoretical 100-year, one-hour storm event (Simons et al., 1982) within the watershed.

Figure 1-3 is a map of the drainage area contributing surface water runoff to Chaco Wash at Pueblo del Arroyo, 627 sq. miles. The National Oceanic and Atmospheric Administration (NOAA) has published nationwide isopluvial rainfall maps for the peak 1-hour, 6-hour, and 24-hour storm events of 100-year return period. In the Chaco Canyon area and much of the San Juan Basin the 1-hr 100-yr peak rainfall value is 1.81 inches. The 6-hr 100-yr peak value is 2.19 inches, and the 24-hr 100-yr peak rainfall value is 2.6 inches (NOAA Atlas 14, 2003).

Hypothetical one-hour precipitation events of 2-, 5-, 10-, 25-, 50-, and 100-year return periods were assumed and used to model runoff within the Chaco Wash watershed (Simons et al., 1982). The runoff hydrographs predict a peak flow of 19,860 cfs at Pueblo del Arroyo for the 100-year 1-hour storm. This translates to a



water surface elevation just four feet below the top of the arroyo wall at Pueblo del Arroyo (Simons et al., 1982). Such a peak flow would persist for only about ½ hour (0.5 hours). Computer simulations of runoff associated with the 1-hour 50- and 100- year precipitation events have confirmed these conclusions (RMC, 2002a).

Flows of greater than 1,200 cfs exceed the capacity of the inner channel. Flows of greater than approximately 1,600 cfs begin to impinge on the toe of the arroyo wall (RMC 2002a). Analysis of streamflow records from a gauging station maintained by USGS at CCNHP from 1976 to 1990 indicate that the highest flows generally occur during July, August and September.

### 1.3 Purpose

The purpose of the proposed erosion control action at Chaco Culture National Historical Park (CCNHP) is to comply with general NPS mandates and policies regarding resource management (Organic Act (16 USC 1), Presidential Proclamation 740, NPS Management Policies (2001a), etc.) and also with CCNHP's Resource Management Plan (RMP) (2003). The RMP states that the primary objective of resource management at CCNHP is to preserve and protect park features, including historic and prehistoric structures, items in the collection, the cultural landscape, ethnographic resources and traditional uses (NPS, 2003a).

The erosion control action is intended to reduce risk of damage associated with erosion caused by infrequent flood-stage flows in Chaco Wash, while maintaining to the integrity of the great house structure and the cultural landscape. This does not imply that all measures whatsoever will be considered, but that the measures adopted need to be sufficient to achieve the goal. The action needs to balance the positive and negative effects of preserving Pueblo del Arroyo in a way that minimizes adverse impacts while maximizing the beneficial impacts.

### 1.4 Need

The erosion control project at Pueblo del Arroyo is needed to address the following concerns:

- Recent study by the USGS (Gellis, A., 2002) has confirmed that the arroyo is presently undergoing an aggradational phase, i.e., sediment is accumulating, causing the grade elevation of the arroyo floor to increase. This aspect can be expected to contribute to floodwater elevations within the arroyo that are closer to that of the canyon floor and Pueblo del

- Arroyo. As a result, the risk of inundation of a cut-off chute that has formed near the southwest corner of the structure is also increasing. Inundation of this chute and associated erosion could seriously undermine this portion of Pueblo del Arroyo and associated structures.
- The arroyo wall immediately upstream of Pueblo del Arroyo and the cut-off chute is highly susceptible to erosion due to its location along the downstream, outside edge of a meander (see Figure I-2). It is at such locations that flood waters undergo the greatest acceleration against the vertical arroyo walls, leading to undercutting and slumping. Continuation of this process will bring the arroyo wall closer to Pueblo del Arroyo, increasing instability and the risk of structural damage to the south and southwest portions, to the tri-wall structure, and to the buried structural feature on the soil island that makes up the south side of the cutoff chute.

## 1.5 Project Objectives

Based on the Purpose and Need for the project, summaries of NPS internal and external scoping, and Tribal consultation the following objectives have been identified for the erosion control project at Pueblo del Arroyo:

- Long-term stabilization of the arroyo wall adjacent to Pueblo del Arroyo that will decrease the likelihood of damage to the structure and of further loss of un-excavated cultural material in the site area.
- Implementation of an erosion control/stabilization measure that will not adversely affect resources and values of the Park, especially cultural resources, nor adversely affect the ability of the public to enjoy these sites.
- Implementation of a low-maintenance, long-term erosion control/stabilization measure that will provide protection to Pueblo del Arroyo from erosion in the event of a 100-year flood event in the arroyo.

## 1.6 Project Scoping

Scoping for the Pueblo del Arroyo Erosion Control EA was initiated by NPS in 1998 by contracting the U.S. Bureau of Reclamation (BOR) to prepare recommendations for long-term erosion control measures at three major cultural sites located along Chaco Wash. For Pueblo del Arroyo, BOR recommended installation of a structural revetment along the arroyo wall, as shown in Figure I-2 (U.S. BOR, 1998). The revetment would armor (stabilize) the north arroyo wall through a distance of 1,200 feet, extending along the west and south side of the great house (approximately 600 feet), and upstream along the outside curve of

the arroyo meander (approximately 600 feet). The BOR recommended armoring the arroyo wall either with riprap, gabion mattress, or soil cement.

Following review of the BOR-recommended erosion control measures, NPS staff conducted additional internal and external scoping to formulate an Environmental Assessment outline. This outline was synthesized to formulate an Environmental Assessment (EA) Scope of Work. The EA Scope of Work included study areas and associated tasks necessary for preparation of a comprehensive EA. Study areas/tasks identified include:

- The degree to which prehistoric structures, specifically Pueblo del Arroyo, are at risk from erosion during flooding in Chaco Wash. The high-flow flood events in Chaco Wash predicted in previous studies are rare, and it is possible that flood-stage flows capable of eroding the arroyo wall adjacent to Pueblo del Arroyo may not occur for many years. Within the last half of the 20<sup>th</sup> century, conditions in the arroyo appear to have been changing more to those of overall deposition as opposed to erosion. Reasons proposed for this trend involve many potentially interrelated factors, and previous erosion control efforts have added to the list of variables. In light of this uncertainty, as well as observed current conditions, the NPS has entered into an Interagency Agreement with the U.S. Geological Survey (USGS) to characterize long-term erosion/sedimentation conditions in the canyon in an effort to evaluate, as accurately as possible, the risk of erosion-related damage to Pueblo del Arroyo as well as other Chacoan structures.
- The presence of surveyed and un-surveyed archeological resources in the subsurface around Pueblo del Arroyo. Active erosion control measures would potentially involve impacts to archaeological resources. Several small sites of potential archaeological significance have been identified along the construction alignment. The New Mexico State Historic Preservation Office has been consulted to identify issues of compliance with the National Historic Preservation Act (16 U.S.C. 470).
- The BOR-recommended action would involve placement of fill material in the Waters of the United States (through re-alignment of a segment of the inner channel) and would require a Department of the Army permit as required under Section 404 of the Clean Water Act (33 U.S.C. 26 Sect. 1344). In addition to placement of fill, the proposed action would involve some additional disturbance to the riparian environment in Chaco Wash, from access routes to the construction site within the arroyo. Consultation with the U.S. Army Corps of Engineers, (Albuquerque District) has been conducted to insure compliance with the proper permitting procedures (RMC, 2002b).
- Consultation with the New Mexico Game and Fish Department and preparation of a Threatened and Endangered (T & E) Species Survey was



identified as necessary component of the EA. The Endangered Species Act of 1973 (P.L. 93-205; 16 U.S.C. 35 Sect. 1531), mandates protection of federally listed Threatened and Endangered Species. The NPS extends this responsibility to protecting federal candidate species (proposed Threatened and Species of Concern), state-listed, and state-candidate species. A Threatened and Endangered Species survey was completed for the site area. There are no T & E species that would be adversely affected by the proposed action.

- Previous study has identified instances where erosion control efforts have exacerbated erosion conditions elsewhere in the arroyo. Implementation of erosion control measures may cause a decrease in the cross-sectional area of the arroyo, or an increase or decrease in roughness (resistance to flow caused by structures). Analysis of extreme flow conditions (hydrologic modeling) in the arroyo associated with predicted 50- and 100-year storm events of maximum intensity was completed (RMC, 2002a) to assess the effect that installation of the BOR-proposed revetment may have on the hydraulic environment. The results of the computer modeling study are discussed in Section 3.1.2.
- Vibration from construction machinery could compromise the structural integrity of the great house. A detailed assessment of minimum safe distances for construction machinery from the Pueblo del Arroyo structure is a critical component of any proposed action. Vibration analyses were conducted at Pueblo del Arroyo utilizing various typical construction machinery and vehicles to determine minimum safe distances (King, K., 2001)
- Maintaining a “natural” appearance was identified as a key component for all alternatives.
- Park Visitor access may be re-directed during construction activities. The one-way Loop Road near Pueblo del Arroyo represents the main access route for construction equipment, as well as Visitor automobiles. Visitor access trails around the perimeter of Pueblo del Arroyo pass very close to the top of the arroyo wall where construction would take place. For visitor safety reasons, access to a portion of one interpretive trail at Pueblo del Arroyo would be restricted temporarily during construction. Warning signs and/or flagmen may also be necessary on the loop road during those times when construction machinery would be present on the road.
- Interpretation of the erosion control project for visitors via wayside exhibits or publications was identified as a necessary component of all alternatives.
- Ensuring long-term protection of the great house from erosion associated with a 100-year flood in the arroyo, while preserving the integrity of the cultural landscape (NPS, 1999a), was identified as a key component for all

alternatives. Consideration of all reasonable and practical erosion control alternatives was recommended.

Additional public scoping for this project was implemented through onsite consultation with the U.S. Geological Survey and representatives from several Pueblos and Indian Nations of the Four Corners area (CCNHP Tribal Consultation Group). At this time (July 2001), analysis of the BOR proposed alternative (hard slope protection/revetment) had identified it as an approach that would compromise the cultural landscape to an unacceptable degree.

Analysis and comments from the USGS and tribal representatives led to the formulation of, initially, the Intermittent Structures alternative and then the NPS preferred alternative. These alternatives were developed based on assessments of (1) the arroyo as a net depositional environment and of (2) ideas and opinions from tribal representatives ranging from encouragement for doing all that is possible to preserve Pueblo del Arroyo, to allowing erosion to reclaim the structure as part of the natural order.

The range of approaches to erosion control at Pueblo del Arroyo received from tribal consultation must be synthesized with NPS and CCNHP policies regarding preservation. NPS and CCNHP policies are fairly clear with regard to preservation of prehistoric great house structures and so were judged to provide more direction in selecting alternatives than the range of approaches obtained from tribal consultation.

Analysis by the USGS indicates the arroyo is undergoing net deposition over time. This observation led to the conclusion that flood elevations will increase over time, increasing the likelihood of large-volume flows through the cutoff chute. Also, historical records show that cable-rail fencing has been a successful method of stabilizing the arroyo floor and walls, at the locations where it has been employed (Simons et al., 1982). Cable-rail fencing enhances sedimentation while preventing erosion, eventually burying the fencing. Accordingly, the NPS preferred alternative incorporated elements designed to address the two central flood-related erosion control issues at Pueblo del Arroyo: stabilizing the arroyo wall and mitigating the potential for flow through the cutoff chute.

The following Chapters contain the elements of this EA. Information describing the proposed action and potential alternatives associated with the erosion control project at Pueblo del Arroyo (Chapter 2), the Affected Environment (Chapter 3), followed by detailed descriptions of environmental consequences associated with the proposed action and the identified alternatives (Chapter 4). Chapter 5 lists people who have been consulted and/or contributed to the preparation of this EA.

## 1.7 Erosion Control Issue Topics Retained For Consideration

### **Floodplains/Waters of the U.S.**

Executive Order 11988, *Floodplain Management*, requires all federal agencies to avoid construction within the 100-year floodplain unless no other practicable alternative exists. Certain construction activities within a 100-year floodplain require preparation of a Statement of Findings. Section 404 of the Clean Water Act authorizes the U.S. Army Corps of Engineers to prohibit or regulate, through a permitting process, discharge of dredged or fill material or excavation within U.S. waters. This impact topic was selected since the alternatives considered would involve work within the Chaco Wash floodplain.

### **Soils**

According to the National Park Service's Management Policies (2001a), the National Park Service will strive to understand and preserve the soil resource of park units and to prevent, to the greatest extent possible, the unnatural erosion, physical removal, or contamination of the soil, or its contamination of other resources. Soils within the project area are silty fine sands that are susceptible to erosion from water unless stabilized. Since all of the alternatives except the no-action alternative would involve varying degrees of heavy machinery use and/or (temporary) road construction on the arroyo bottom, disturbance to soils was retained for analysis as an impact topic.

### **Vegetation**

NPS Management Policies (NPS, 2001a) require maintenance of all native plant communities as part of the natural ecosystems of parks, including preservation and restoration of natural abundances, diversities, dynamics, distributions, habitats, and behaviors of native plant populations. Management policies also require minimization of human impacts on native plant populations, communities, and ecosystems, and the processes that sustain them. Since the active alternatives considered involve damage and/or removal of both native and non-native plants within the arroyo, as well as import of soil fill material into the arroyo, vegetation was selected for analysis as an impact topic.

### **Cultural Resources**

The National Historic Preservation Act, as amended in 1992 (16 USC 470 *et seq.*); the National Environmental Policy Act of 1969 (42 USC 4321 *et seq.*); and the

National Park Service's Director's Order #28, *Cultural Resource Management Guideline* (1997), *Management Policies*, 2001 (2000), and Director's Order #12, *Conservation Planning, Environmental Impact Analysis, and Decision Making* (NPS, 2001b) require the consideration of impacts on Cultural Resources, including historic sites, structures or objects listed or eligible for listing in the NRHP. Cultural Landscapes, Ethnographic Resources and Archaeological Resources meeting NRHP criteria are also included. Since all of the alternatives involve some degree of potential impact to at least one of each of these Cultural Resource categories, Cultural Resources was selected as an impact topic for analysis.

### **Visitor Experience/Natural Soundscapes**

Enjoyment of park resources and values by visitors is part of the fundamental purpose of all parks. The Service is committed to providing appropriate, high quality opportunities for visitors to enjoy the parks, and will maintain within the parks an atmosphere that is open, inviting, and accessible to every segment of society (NPS Management Policies, 2001a). Due to the location of Pueblo del Arroyo at the turn-around point of the Visitor Loop Road, and the popularity of the Pueblo del Arroyo parking lot as a trailhead for the Pueblo Alto and Penasco Blanco trails, potential impacts to visitor experience from construction activities are likely. The use of heavy machinery involved in several of the alternatives considered would pose a potential impact upon the natural soundscape and also restrict access to portions of the interpretive trail at Pueblo del Arroyo.

## **1.8 Erosion Control Issue Topics Dismissed From Further Consideration**

Additionally, environmental impact topics that may be analyzed during NEPA environmental assessment were dismissed from further consideration as follows:

### **Air Quality**

Section 118 of the 1963 Clean Air Act (42 U.S.C. 7401 *et seq.*) requires a park unit to meet all federal, state, and local air pollution standards. Further, the Clean Air Act provides that the federal land manager has an affirmative responsibility to protect air quality-related values (including visibility, plants, animals, soils, water quality, cultural resources, and visitor health) from adverse pollution impacts. Air quality in CCNHP is generally good, due to its remote location and setting.

Erosion control construction activities such as hauling fill and other materials and operating heavy equipment could result in temporary increases of vehicle exhaust, particulate emissions, and fugitive dust in the area of the park. However, since the project would be implemented during the low visitor use (winter months) time of year, such increases are unlikely to exceed levels typically present during high use times of the year. Any degradation would be temporary, and cease upon completion of the project. Overall, the project would result in a negligible decrease in air quality. Therefore, air quality was dismissed as an impact topic.

### **Wildlife including Threatened and Endangered Species**

Federal, State, County, regional, Navajo Nation, and Park resources were reviewed to identify threatened and endangered species and species of concern in the CCHNP area. A Threatened and Endangered Species Survey was completed in July 2001 (North Wind, 2001) for the purposes of assessing the presence or absence of such species in the site area. *Endangered species* are those in danger of extinction throughout all or a significant portion of its range (Endangered Species Act §3(6)). *Threatened species* are those likely to become endangered within the foreseeable future throughout all or a significant portion of its range (ESA §3(20)). *Sensitive species or species of concern* is an informal term that refers to those species which the U.S. Fish and Wildlife Service believes might be in need of concentrated conservation actions. In the Pueblo del Arroyo, erosion control project area there is no suitable habitat for threatened and endangered species (North Wind, 2001). For this reason the topic of threatened, endangered, or sensitive species was dismissed from consideration.

### **Water Quality**

The potentially affected environment for the impact topic of Water Quality includes surface water and shallow groundwater. The surface water environment consists of Chaco Wash downstream from the Pueblo Bonito Bridge. The groundwater environment consists of the shallow water table aquifer beneath the floor of Chaco Canyon in the Pueblo del Arroyo area and downgradient (i.e., down-canyon).

New Mexico has adopted the U.S. EPA's anti-degradation policy regarding surface water and groundwater i.e., "*Existing instream water uses and the level of water quality necessary to protect the existing uses shall be maintained and protected in all surface waters of the state*" (NMAC 20.6.2). Furthermore, with regard to protection of groundwater, Sections 20.6.2.3000-3114 NMAC specifically regulate discharges onto or below the surface of the ground so as to "*protect all ground water of the state of New Mexico which has an existing concentration of 10,000 mg/l*

*or less TDS, for present and potential future use as domestic and agricultural water supply...”,*

Water quality is not anticipated to undergo impact by any of the alternatives considered due to preventative practices (mitigation of potential impacts) designed to eliminate the possibility of adverse water quality impacts related to releases of motor fuels and lubricants. With regard to potential increases in sediment load due to disturbance of floodplain soils, impacts would be negligible due to the typically high sediment loads in the wash during flow events. USGS sedimentation studies in the Rio Puerco, a New Mexico entrenched arroyo similar to Chaco Wash, indicate typical suspended sediment loads range from 4000 mg/L to 50,000 mg/L and higher under low to moderate flow conditions (USGS Suspended Sediment Database). Chaco Wash is an example of this arroyo type where suspended sediment loads are naturally high, (Gellis, A., 2000; Aby et al., 1997). Due to the negligible impact to water quality from the alternatives considered, water quality was dismissed from further consideration.

## **Wetlands**

Chaco Wash is not listed in the New Mexico Wetlands Inventory (New Mexico Environment Department, 2000). Sites not listed specifically as Wetlands can still qualify for protection under Section 404 of the Clean Water Act if meeting the criteria for “jurisdictional wetlands”. Qualification as a jurisdictional wetlands area requires that the three (3) wetlands characteristics as described in the USACE Wetlands Management Handbook (Schneider et al., 2000) be present. These are: **soils, hydrology, and vegetation**. These characteristics are defined as follows:

- The substrate is predominantly undrained **hydric soil**. Hydric soil is a soil that is saturated, flooded or ponded long enough during the growing season to develop anaerobic (depleted oxygen) conditions that favor the growth and regeneration of hydrophytic vegetation.
- The area exhibits **wetland hydrology**. Wetland hydrology encompasses all hydrologic characteristics of areas that are periodically inundated for a minimum of 5% of the growing season most of the time (greater than 50% probability for a given year).
- The area supports, under normal conditions, a prevalence of **hydrophytic vegetation**. Hydrophytic vegetation is prevalent in an area when the dominant species comprising the plant community or communities are typically adapted for life in saturated soil conditions (NMED, 2000).

The Wetlands Management Handbook indicates that soils may be considered hydric, if they are inundated continuously for at least one week during the

growing season during most years. A draft soil survey being prepared for CCNHP (NRCS, in progress) indicates hydric soils are not present in Chaco Wash. Wetlands hydrology is not present within the arroyo, except within the un-vegetated inner channel (see Figure 1-2), where continuous flow for longer than one week's duration is not uncommon during August and September. Rare localized portions of the inner channel have been colonized by willow; however, these areas are not present at the Pueblo del Arroyo construction site, and would not be affected by any proposed erosion control activities. The riparian environment within the arroyo does not qualify as jurisdictional wetlands; for this reason the topic of wetlands was dismissed from further consideration.

### **Prime and Unique Farmlands**

Prime or unique farmland is defined as soils that particularly produce crops such as common foods, forage, fiber, and oil seed. Unique farmland produces specialty crops such as fruits, vegetables, and nuts. None of the soils in CCNHP are planned to be or are currently used for crop production (Zschetzsche, S. and Clark, G. H., 2004). For this reason the topic of prime and unique farmlands was dismissed from further consideration.

### **Environmental Justice**

Executive Order 12898, General Actions to Address Environmental Justice in Minority Populations and Low-Income Populations” requires all federal agencies to incorporate environmental justice into their missions by identifying and addressing disproportionately high and adverse human health or environmental effects of their programs and policies on minorities and low-income populations and communities. The proposed action would not have health or environmental effects on minorities or low-income populations or communities as defined in the U.S. Environmental Protection Agency’s Environmental Justice Guidance. (1998). The environmental justice impact topic was dismissed from further consideration.

### **Regional Economy**

The National Environmental Policy Act requires analysis of the effects of proposed actions on the regional economy. The local economy and most businesses within the communities adjacent to the park are based on professional services, construction, tourism, and light industry. Implementation of any of the active alternatives considered would result in short-term economic benefits the local and regional economy from construction related expenditures. Any increase, however, would be negligible and temporary, lasting only as long as

construction. Therefore, regional economy was dismissed as an impact topic in this document.

### **Concessions**

There are no concessions at Chaco Culture National Historical Park. Therefore, concessions were dismissed as an impact topic.

### **Lightscape Management**

Work on the project is anticipated to be performed during daylight hours. The park would not authorize illumination of the work site at night. Further, the Visitor Loop Road portion of CCNHP is closed at sunset and open at sunrise. For these reasons, lightscape management was dismissed as an impact topic.

### **Visitor Safety**

Since all construction activities would take place in areas closed to visitor access, impacts to visitor safety would be negligible. Accordingly visitor safety was dismissed from further consideration as an impact topic. Public safety measures would be observed during all project activities.

In addition to typical exclusion-zone demarcation (caution flagging or “do-not-cross” flagging and related signage and/or active access control), temporary interpretive exhibits would be placed at the head of the entrance trail from the Pueblo del Arroyo parking lot. Such exhibits would educate visitors on the purpose and schedule of the Pueblo del Arroyo Erosion Control Project. Alternate routes for viewing the site, e.g., the Pueblo Alto Trail, would be identified.

Public safety standards require the use of protective fencing and barricades for safety as necessary during construction project. Any closures or restrictions require a written determination by the superintendent that such measures are needed to protect public health and safety, prevent unacceptable impacts to park resources or values, or otherwise implement management responsibilities (NPS Management Policies, 2001a).



## 2.0 Alternatives Considered

Three erosion control alternatives for reducing flood-related damage to Pueblo del Arroyo are analyzed. These are 1) the No-action alternative, 2) the Preferred Alternative, a combination of fill emplacement, cable-rail fencing, and establishment/enhancement of vegetative cover, and 3) intermittent erosion control structures in the form of fencing and jetty fields. Installation or implementation of the latter two alternatives would take place during the time of year when both visitation and flooding are typically of lowest frequency, i.e., the period from December to April.

### 2.1 Alternative 1: No-Action Alternative

The no-action alternative entails allowing natural processes in the canyon and the arroyo to proceed without introduction of erosion control measures. Overall the arroyo floodplain is undergoing net deposition, or aggrading as flood events build up the arroyo floor (Gellis, A., 2002). As the floodplain aggrades, the vertical relief between it and the canyon floor decreases, ultimately leading to more stable arroyo walls. However, it will likely take several centuries for the arroyo completely fill in. During this time, erosion of the arroyo wall during a 50- or 100-year flood event may be expected to reduce the arroyo wall stability or undermine the arroyo wall at Pueblo del Arroyo, leading to damage of the great house structure.

This damage to the site would also likely include closure of the interpretive trail along the south side of Pueblo del Arroyo. Mitigation of these adverse effects upon visitor experience would include interpretive programs that would educate the public regarding the natural arroyo cycle and the inevitability of erosion at the site and in the canyon as a whole.

### 2.2 Alternative 2: NPS Preferred Alternative

The NPS preferred alternative would stabilize the arroyo wall at key locations using permanent cable-rail fencing, soil fill, and native vegetation along the base of the arroyo wall. Fill (approximately 4,000 cubic yards of soil) would be placed in the cut-off chute (see Figure 2-1). This would create a continuous generally flat surface of approximately 6,600 sq. feet, extending between Pueblo del Arroyo and the soil island that makes up the south edge of the chute. A permanent cable rail fence would be established along selected segments of the base of the arroyo wall. The fencing would be installed along the downstream, outside edges of three meander bends in the vicinity of Pueblo del Arroyo as appropriate. Portions of these areas are currently well-protected by cottonwoods and/or tamarisk, which would not be

disturbed. The upstream fence segment would be along the north arroyo wall immediately south and southeast of Pueblo del Arroyo.

Two additional segments would be installed along 1) the south arroyo wall west-southwest of Pueblo del Arroyo, and 2) the north arroyo wall immediately northwest of Pueblo del Arroyo. These segments would protect two (NRHP-eligible) archaeological sites exposed in the arroyo wall that are related to the Pueblo del Arroyo complex.

Following installation of the fencing, soil fill would be placed against the base of the arroyo wall to a height equal to half that of the arroyo wall (Figure 2-1). This fill would be placed along the length of each of the fence segments (total of 1,000 feet of arroyo wall, for a total of approximately 2,500 cubic yards of soil fill), partially burying the fencing. This arroyo wall fill would cover a footprint approximately 16,000 sq. feet, or 0.36 acre. Native vegetation would be seeded, planted, and irrigated by a shallow well, hand- or electrically (solar DC power) operated pump until firmly established to provide soil-stabilizing cover. Irrigation would be discontinued once the vegetation was established. All fill placement and construction would take place in a single season.

During implementation of the project, interpretive exhibits would be installed to inform the public of the purpose and need for the erosion control project, the history of the arroyo cycle and stream dynamics in Chaco Wash and their effect on Pueblo del Arroyo, and the function of each erosion control component. Also, information about the park's ongoing preservation program at each of the great house structures would be included.

## 2.3 Alternative 3: Intermittent Erosion Control Structures

Alternative 3 would stabilize the arroyo wall and the adjacent floodplain using jetty fields and fencing. The installations would be at the same locations as the fencing installed in the preferred alternative. No fill would be placed in the arroyo under Alternative 3. Natural sedimentation as a result of the flow-retarding capability of the jetty fields would serve to stabilize the floodplain over time. It is estimated that it would take 50 to 70 years for the jetties to become buried by sediment. During this time, large floods like the 100- year event would still impinge directly on the arroyo wall within the cutoff chute at the southwest corner of Pueblo del Arroyo, although flow velocities would likely be lower than without the jetty fields.

A permanent cable-rail fence would be installed along (parallel) to the base of the arroyo wall at the same locations as for the preferred alternative, to stabilize and prevent undercutting of the wall. Three permanent jetty fields (A, B, and C), consisting of additional cable-rail fencing sections installed perpendicular to the arroyo wall, would then be installed between the arroyo wall fencing and the inner

channel (see Figure 2-2). It has been noted that the use of flow-retarding structures along one side of the channel has the effect of increasing flow velocity on the opposite side, potentially causing increased erosion just downstream (on the opposite side) from of the structures (Simons et al., 1982). The two downstream jetty fields B and C would stabilize and protect the two (NRHP-eligible) archaeological sites exposed in the arroyo wall at these locations.

The jetty fields would be installed over approximately 2 acres on the arroyo floodplain to retard high-velocity flow on the downstream, outside edges of meander bends in the Pueblo del Arroyo vicinity (see Figure 2-2). Two jetty fields (Fields A and C) would be installed on the north arroyo floodplain. The upstream jetty field (A) would cover 0.86 acres. The downstream jetty field (C) would cover 0.56 acres. Jetty field B would be installed on the south side of the arroyo floodplain between A and C and would cover 0.38 acres.

Similar to the preferred alternative, interpretive exhibits would be installed to inform the public of the purpose and need for the erosion control project, the history of the arroyo cycle and stream dynamics in Chaco Wash and their effect on Pueblo del Arroyo, and the function of each erosion control component. Also, information about the park's ongoing preservation program at each of the great house structures would be included.

## 2.4 Alternatives Dismissed From Further Consideration

The alternatives considered in this EA focus on erosion control at the Pueblo del Arroyo complex. Several other alternative erosion control approaches involving measures to be implemented at locations other than at Pueblo del Arroyo, or involving measures other than erosion control, were initially considered during NPS internal and external scoping, but were eliminated from further evaluation due to the unforeseeable effects of implementation or adverse impacts upon park resources and values. These include:

- **Arroyo Wall Revetment Construction:** The BOR (1998) recommendation involves installation of hard slope protection along the south and west sides of Pueblo del Arroyo, armoring the arroyo wall in the form of a revetment. The revetment would compromise the integrity of the cultural landscape to an unacceptable degree through installation of slope armoring material. Likely damage to several small archaeological sites exposed in the arroyo wall would further compromise legislation and NPS policies (Public Law 96-550; CCNHP GMP, 1984; CCNHP RMP, 2003). In addition, the need for significant excavation within the arroyo and modification of the existing inner channel alignment would conflict with floodplain management policies, i.e., avoidance

of actions that could adversely affect natural resources (NPS, 2001 – Chapter 4, Sect. 4.6.4).

- **Upstream Retention Basin in Chaco Wash:** Construction of large retention basin(s) upstream from sensitive sites to intercept runoff, and decrease downstream flow volumes was proposed as an alternative (onsite Tribal Consultation meeting of July 17, 2001). NPS Management Policies generally dictate that dams and reservoirs will not be constructed in parks, i.e., “the Service will manage watersheds as complete hydrologic systems, and will minimize human disturbance to the natural upland processes that deliver water, sediment, and woody debris to streams” (NPS, 2001).
- **Arroyo widening along south arroyo wall at Pueblo del Arroyo:** An alternative was proposed involving excavation of a large volume of soil from the south arroyo wall through the critical reach, to increase the carrying capacity of the arroyo, resulting in lower flood stages (onsite Tribal Consultation meeting of July 17, 2001). This approach was determined to be too likely to pose unacceptable impacts to known and potential unidentified archaeological resources in the subsurface, as well as potential adverse impacts to the floodplain, soils, and existing vegetation.
- **Watershed-scale Drop-structure/Check-dam Construction:** Drop-structures or check-dams were identified as an alternative for erosion control (internal NPS scoping). Such structures control erosion along a runoff channel by retaining some portion of runoff and also sediment behind the structure(s), resulting in a decrease in gradient and flow velocity over most of the channel length. However, previous experience in the Park has indicated that under extremely high flows drop structures are subject to undermining and failure at a high enough frequency to make their use questionable for erosion control during extreme flood conditions (Simons et al., 1982).
- **Watershed-scale Erosion Control:** It was recommended during the tribal consultation meeting of July 17, 2001, that the Park should consider widening the scope of investigation and implement erosion control structures across the entire Chaco watershed (e.g., retention basins, check dams) (onsite Tribal Consultation meeting of July 17, 2001). Although this scope may address watershed-wide concerns, the scope of the EA was narrowed to ensure the best protection possible for Pueblo del Arroyo from local as well as regional watershed effects. The Park can predict and determine effects from the installation of a local erosion control structure through local watershed dynamics studies (Gellis, A., 2002; Malde, H. 2000; RMC, 2002a; Vincent, K., in progress). However, the effects a watershed-wide erosion control structure strategy are scientifically difficult if not impossible to validly predict. Such a strategy would not lend itself to accurate predictions of watershed wide effects, nor incorporate the best localized protection available for Pueblo del Arroyo.

For this reason, implementation of a watershed-wide erosion control approach to reduce risk of damage at Pueblo del Arroyo was dismissed from further consideration.

- **Vegetative Cover Slope Protection:** This approach would be similar to the BOR (1998) recommendation except that native vegetation would be used to stabilize a constructed slope along the north arroyo wall adjacent to Pueblo del Arroyo. While this approach would cause less adverse impact to the cultural landscape, it requires re-alignment of the inner channel to allow for establishment of the 1:2 slope. NPS Management Policies stipulate against stream manipulation if at all possible (NPS, 2001, Section 4.6) Possible damage to several small archaeological sites exposed in the arroyo wall would further compromise preservation mandates.

## 2.5 Mitigation Measures

Mitigation measures are included and analyzed where applicable as part of each active alternative. These actions have been developed to lessen the adverse effects associated with each alternative. Primary mitigation measures include the following measures:

- Plantings would use species native to the Park from genetic stocks originating in San Juan County. Re-vegetation objectives would be to re-establish native grass and shrub cover on the arroyo floor where disturbance from construction would take place. Any fill material used would be from approved sources, and free from seeds of exotic plant species. Further, fill borrow areas would also be re-vegetated with native grasses, to minimize exotic or noxious weed populations in borrow area(s) located outside the park.
- If during construction previously undiscovered archeological resources are discovered, all work in the immediate vicinity of the discovery would be halted until the resources could be identified and documented and an appropriate mitigation strategy developed, if necessary, in consultation with the New Mexico State Historic Preservation Office. In the unlikely event that human remains, funerary objects, sacred objects, or objects of cultural patrimony are discovered during construction, provisions outlined in the Native American Graves Protection and Repatriation Act (25 USC 3001) of 1990 would be followed.
- Construction activities would take place during the winter (December-March), when visitor use and also flow within the wash are typically of lowest frequency. Temporary interpretive wayside exhibits or tour booklets would be installed during periods of restricted access to Pueblo del Arroyo, describing the purpose and need for erosion control measures at the site. These exhibits would include

interpretation of the site's location in the middle of the floodplain, the stream dynamics of the arroyo and the arroyo cycle, and the range of philosophies regarding preservation of great house structures, especially between NPS and some modern Pueblos..

- Standard erosion control measures, such as mulch matting would be employed on disturbed ground within the arroyo until re-vegetation was achieved.
- To minimize the risk of impacts to surface water or groundwater, all machinery would be inspected daily for leaks. All machinery and crews would have on hand the necessary equipment and be briefed on measures to be taken in the event of an accidental release.

Additional mitigation measures are described under impact analyses for the alternatives considered in Section 3.0.

## 2.6 Environmentally Preferred Alternative

The environmentally preferred alternative is determined by applying the criteria suggested in the National Environmental Policy Act of 1969 (NEPA), which is guided by the Council on Environmental Quality (CEQ). The CEQ provides direction that “[t]he environmentally preferable alternative is the alternative that will promote the national environmental policy as expressed in NEPA’s Section 101. The environmentally preferred alternative will:

1. fulfill the responsibilities of each generation as trustee of the environment for succeeding generations;
2. assure for all generations safe, healthful, productive, and esthetically and culturally pleasing surroundings;
3. attain the widest range of beneficial uses of the environment without degradation, risk of health or safety, or other undesirable and unintended consequences;
4. preserve important historic, cultural and natural aspects of our national heritage and maintain, wherever possible, an environment that supports diversity and variety of individual choice;
5. achieve a balance between population and resource use that will permit high standards of living and a wide sharing of life’s amenities; and
6. enhance the quality of renewable resources and approach the maximum attainable recycling of depletable resources.

The environmentally preferred alternative is the strategy that best achieves the purpose of the proposed action while causing the least adverse effect on the

environment, i.e., the preferred alternative achieves the intent of NEPA to the greatest degree. The preferred alternative selected by NPS achieves these goals to the greatest degree of the alternatives considered.

Alternative 1 (No Action) does not fully realize provisions 1 through 6 of the Section 101 goals, due to the risk of flood-caused damage to the great house structure. While the no-action alternative strives to meet the goals of policies 1 through 4 by avoiding impacts to vegetation, soils, and floodplain/waters of the U.S., the long-term minor to potentially moderate adverse long-term effects upon cultural resources, resource values, and visitor use engendered by no action represent a much larger degree of adverse effect. It is the long-term nature of the potential damage to Pueblo del Arroyo that engenders the greatest adverse effect, compared to the avoidance of negligible to minor temporary impacts to other resources achieved by the no-action alternative. Also, the no-action alternative would allow for preventable degradation of a non-renewable resource with no accompanying benefit to society. The aspects of the No-action Alternative are summarized:

Goal 1: Least fully fulfills goal 1 because damage to Pueblo del Arroyo must be expected due to the likelihood of erosion during a 100-year flood. This approach does not preserve an irreplaceable cultural resource for future generations, except in an interpretive fashion.

Goal 2: Generally fulfills Goal 2 because damage to Pueblo del Arroyo would be localized within the scale of the entire park cultural landscape, and safety concerns would be mitigated by trail closure and/or re-routing. Some damage to the esthetics of the site would be caused by damage.

Goal 3: Does not fully fulfill Goal 3 because damage to Pueblo del Arroyo would represent localized degradation of the cultural environment at one of the main visitor use sites.

Goal 4: Does not fully fulfill Goal 4 because it fails to preserve a historic/cultural aspect of world heritage.

Goal 5: Does not fully fulfill Goal 5 because in allowing preventable degradation of the cultural resource (Pueblo del Arroyo), it detracts from the general standard of living by reducing opportunities for cultural growth and edification within the populace. In this manner, there is no benefit to any portion of the population while at the same time use of the resource is at best diminished.

Goal 6: Does not fully fulfill Goal 6 because it neglects any action to prevent depletion of a non-renewable resource (pre-historic great house structures).

Alternative 2 (NPS Preferred Alternative) is a combination of erosion control measures, including placement of fill in critical areas along the arroyo wall at Pueblo del Arroyo in conjunction with sedimentation fencing along the toe of the

arroyo wall, as well as re-establishment of native woody vegetation on the arroyo floodplain. The preferred alternative most fully achieves provisions 1 through 6 of the policy goals by reducing the risk of damage to cultural resources and values and allowing visitor appreciation of the site to continue at its current level. Temporary impacts on visitor use, including a minor temporary adverse effect while vegetation was becoming established, would be offset by preservation of both the great house site and the interpretive trail along the south side of Pueblo del Arroyo. The minor adverse effect to vegetation, soils, and the local viewshed/cultural landscape (from the partially buried cable-rail fence) would be mitigated by re-establishment of native woody plants (sagebrush, rabbitbrush, greasewood, saltbush, cottonwoods, and willow). These localized effects would persist for between 2 and 5 years as re-vegetation of disturbed and filled areas proceeds. The aspects of the Preferred Alternative or Alternative 2 with regard the Section 101 goals are summarized:

Goal 1: Most fully fulfills Goal 1 by taking steps to ensure continued integrity of the historic structure and the cultural landscape for succeeding generations.

Goal 2: Most fully fulfills Goal 2 by assuring culturally and esthetically pleasing surroundings while minimizing adverse impacts to the same.

Goal 3: Most fully fulfills Goal 2 because it assures continued use of interpretive trails and appreciation of the great house structure through use of measures that affect streamflow dynamics to a minimal degree.

Goal 4: Most fully achieves Goal 4 because it preserves the great house structure and cultural landscape to the greatest degree by minimizing the risk of erosion-related damage and maintains the choice of experiencing the site as fully as possible for future generations.

Goal 5: Most fully achieves Goal 5 because it maintains opportunities for cultural growth and edification (generally accepted indicators of a high standard of living), thus helping to maximize continued resource use by the domestic and international populations.

Goal 6: Most fully achieves Goal 6 because it involves preservation of a non-renewable resource (pre-historic great house structures).

Alternative 3 (Intermittent Structures) involves the use of cable-rail fences and jetties to stabilize the base of the arroyo wall and encourage net deposition of sediment over the arroyo floodplain in the project area (Figure 1-2). Alternative 3 strives to but does not fully achieve Section 101 policy goals 1 through 6. The shortcomings are related to the moderate-to-major adverse local viewshed impact caused by the jetty fields, which would cover a much larger and more visible area, and persist for a much longer duration than the fencing included as part of the preferred alternative. The cut-off chute would remain open, lending to continued risk of erosion at the southwest corner of Pueblo del Arroyo. Finally, the



installation of jetty fields could cause more dramatic physical change in hydrologic processes, with possibly unintended consequences. The attributes of Alternative 3 -Intermittent Structures with regard to attainment of the Section 101 goals are summarized:

Goal 1: Fulfills Goal 1 to a greater degree than Alternative 1 but to lesser degree than the Preferred Alternative because the jetty field does not reduce risk of erosion-related damage to Pueblo del Arroyo as directly nor as fully as a measure that eliminates flood-stage flow through the cut-off chute.

Goal 2: Does not fully fulfill Goal 2 because the jetty fields would detract from the esthetics and the cultural surrounding to at least as great a degree a damage to the Pueblo del Arroyo structure for at least one generation.

Goal 3: Does not fully fulfill Goal 3 because degradation to the cultural landscape is greater than for the preferred alternative and at least as great as for the no-action alternative, and also would cause the greatest effect upon local streamflow dynamics.

Goal 4: Generally achieves Goal 4 by virtue of protecting Pueblo del Arroyo from flood-related erosion and damage, but disrupts the local natural and cultural setting due to esthetic degradation for one to two generations.

Goal 5: Partially fulfills Goal 5 by taking steps to extend resource use, but does so to a lesser degree than the preferred alternative, while also detracting from the cultural edifice to a greater degree.

Goal 6: Partially fulfills Goal 6, by taking steps to preserve a non-renewable resource, but does so to a lesser degree than the preferred alternative by implementing a less comprehensive preservation strategy.

## 3.0 Environmental Consequences

The methodologies used to evaluate environmental consequences for each of the three main resource categories - natural resources, cultural resources, and visitor use – are explained in the introduction to each major subsection in this chapter. For each impact topic, the analysis includes a description of the affected environment and an analysis of the environmental consequences using the methods and terms consistent with NPS, CEQ, ACHP, and other relevant agency guidance and regulations. The impact analyses involve the following components:

- Identification of the area that could be affected either directly or indirectly.
- Identification of intensity (negligible, minor, moderate, major), context (are the impacts site-specific, local, or regional), and duration (short-term, long-term or permanent), both as a result of this action and from a cumulative effects perspective. Identification of whether effects would be beneficial or adverse (see Glossary for definitions of these terms).
- Identification of mitigation measures that may be employed to offset potential adverse impacts.
- Determine the effect using professional judgment and information provided by statutes, related regulations and guidance, park staff, professional consultants, relevant references and technical literature citations, and subject matter experts.

Cumulative effect analysis is included for each impact topic. Previous activities that contribute to cumulative effects are described under the applicable impact topics below. Other planned projects that may contribute to cumulative effects include:

- Additional erosion control measures have been recommended for other cultural sites within the Park, e.g., the Kin Kletso great house site (Simons et al., 1982). Management policies dictate preservation of other eligible properties exposed elsewhere in the arroyo walls. Such efforts could contribute to cumulative hydraulic adjustments during flooding that may affect erosion within the arroyo.
- The park Cultural Resources Preservation staff implements a regular program of maintenance at Pueblo del Arroyo. This activity consists of re-mortaring of masonry and sealing of the tops of structural walls where exposed to the elements. Such activities retard deterioration of the great house structure.
- Erosion control programs were initiated in Chaco Wash during the 1930s, with the planting of 700,000 trees and shrubs. Planting continued through the following decades, with an additional 15,000 willows planted in 1948, 72,000 willows and tamarisk in 1949, 22,000 willow in 1951, 55,000 willows and cottonwoods in 1953, and 22,000 willows and cottonwoods in 1954. Other smaller planting efforts were not completed until 1961. Cottonwoods (*Populus*

*sp.*) are considered to be native to Chaco Wash, but do not generally propagate readily due to the sporadic water availability. It is reported that many of the seedlings planted by NPS did not survive due to drought (Simons et al., 1982) although new recruitment does occur along the wash banks (Malde, 2001).

- As part of the various erosion control measures implemented in the past, it is reported that during the period 1959-1967, a total of more than three miles of channel (at various locations) were re-aligned within the Park. The main objective of this erosion control program was to reduce or alleviate meandering of the channel where it threatened Park facilities. According to the Superintendent's annual reports, the effects on the floodplain from these actions were judged to be beneficial, in that flood-stage flows remained confined to the re-aligned channel segments, flow velocity over the floodplain was reduced, and erosion along the arroyo wall was minimized (Simons et al., 1982).
- Other activities that have been implemented within the arroyo have included small-scale sedimentation studies involving installation of scour chains, elevation monuments, and test trenches for soil horizon inspection. Bridge installation at two points along the Visitor Loop Road also likely had a local effect on the floodplain.
- A future Park project that may affect soils within the arroyo is active management of the exotic plant species *Tamarix pentandra* (tamarisk), also known as "salt cedar". This project is still in the conceptual stage, and will require NEPA analysis before implementation. Tamarisk is an exotic invasive species that is effective in retarding flood-stage flow velocities in the arroyo. Impacts to floodplain characteristics from such a project could range from minor to moderate, depending upon the management methods used. Short-term reductions in flow-retarding vegetation may be expected to result in increased flow velocity and reduced sedimentation in the area affected. Long-term effects would be *beneficial* due to the reduction in non-native species and improvement of the riparian zone ecology.
- The park Natural Resources Division is currently analyzing the water table elevation changes within the shallow alluvial aquifer that underlies the site. Preliminary research indicates the water table has been dropping, and the depth to shallow groundwater may ultimately exceed the physical limit for plant withdrawal. Analysis completed to date indicates that the tamarisk population in the arroyo has remained stable over the last 20 years (Hanna, L., 2004) and is not expected to spread or propagate naturally.
- Additional studies within the arroyo that are reasonably foreseeable include additional sedimentation, channel morphology, and stream stage monitoring, and vegetation and wildlife inventorying and monitoring.

**A determination of impairment is included in each impact topic analysis considered.** The National Park Service Management Policies 2001 provisions require analysis of potential effects to determine whether or not actions would impair park resources (NPS, 2001a). The fundamental purpose of the national park system, established by the Organic Act and reaffirmed by the General Authorities Act, as amended, begins with a mandate to conserve park resources and values and provide for visitor enjoyment. National Park Service managers must always seek ways to avoid, or to minimize to the greatest degree practicable, adverse impacts to park resources and values. However, the laws do give the National Park Service the management discretion to allow impacts to park resources and values when necessary and appropriate to fulfill the purposes of a park, as long as the impact does not constitute impairment of the affected resources and values. Although Congress has given the National Park Service the management discretion to allow certain impacts within parks, that discretion is limited by the statutory requirement that the National Park Service must leave park resources and values unimpaired, unless a particular law directly and specifically provides otherwise. The prohibited impairment is an impact that, in the professional judgment of the responsible National Park Service manager, would harm the integrity of park resources or values. An impact to any park resource or value may constitute an impairment, but an impact would be more likely to constitute an impairment to the extent that it has a major or severe adverse effect upon a resource or value whose conservation is:

- 1) necessary to fulfill specific purposes identified in the establishing legislation or proclamation of the park;
- 2) key to the natural or cultural integrity of the park; or
- 3) identified as a goal in the park's general management plan or other relevant National Park Service planning documents.

Impairment may result from National Park Service activities in managing the park, visitor activities, or activities undertaken by concessionaires, contractors, and others operating in the park. A determination on impairment is made in the Conclusion section for each of the resource topics analyzed in this chapter.

### 3.1 Natural Resources

Natural Resources that would potentially be impacted by project activities include water quality, soils, floodplains/waters of the U.S., and vegetation.

Determinations of effect for natural resource impact topics are based on consideration of both context and intensity, as described in CEQ regulations. Natural resource intensity and duration context definitions are summarized in Table 3-1. Additional context-defining considerations are identified in the text as applicable.

**Table 3-1  
Natural Resource Effect Definitions**

<b>Impact Topic</b>	<b>Negligible</b>	<b>Minor</b>	<b>Moderate</b>	<b>Major</b>
<b>Soils</b> <i>Short-term - Recovers in less than 3 years. Long-term – Takes more than 3 years to recover.</i>	Soils would not be affected or the effects would be below or at lower levels of detection. Any effects on soil productivity or fertility would be slight.	Effects on soil would be detectable. Effects on soil productivity or fertility would be small, as would be the area affected. If mitigation were needed to offset adverse effects, it would be relatively simple to implement and would likely be successful.	The effect on soil productivity or fertility would be readily apparent and result in a change to the soil character over a relatively wide area. Mitigating measures would probably be necessary to offset adverse effects and would likely be successful.	The effect on soil productivity or fertility would be readily apparent, and substantially change the character of the soil over a large area in and out of the park. Mitigating measures to offset adverse effects would be needed, extensive, and their success could not be guaranteed.
<b>Flood-plains/ Waters of the U.S.</b>	No effects because action would not result in loss of wetlands, compromise floodplain values or processes, or involve permanent placement of fill in waters of the U.S.	Effects would be minimal, but would cause minor disturbance of floodplain values or processes locally, or involve local permanent placement of fill in waters of the U.S.	The action would require a Section 404 (CWA) Army Corps permit, compromise floodplain values over more than 10% of the floodplain, or increase risks of flood-related property loss or reduce public safety. Mitigation would be required, on a local scale, and would have a high success rate.	The action would compromise floodplain values over more than 20% of the floodplain, greatly increase risks of flood-related property loss, or reduce public safety over a large area. Mitigation measures to offset the adverse effects would be required, extensive, and success would not be guaranteed.
<b>Vegetation</b> <i>Short-term - Recovers in less than 3 years. Long-term – Takes more than 3 years to recover.</i>	There would be little to no effect (<3% of total) on Chaco Wash native riparian vegetation. The effects would be on a small scale, and no slow-growing large woody plants (i.e., cottonwoods – <i>populous sp.</i> ) would be affected.	The alternative would affect a relatively minor portion (3 to 15 %) of Chaco Wash native riparian vegetation, excluding cottonwoods. Mitigation to offset adverse effects could be required and would be effective.	The alternative would affect between 15 and 30% of Chaco Wash native riparian vegetation, excluding cottonwoods. Mitigation to offset adverse effects could be extensive, but likely would be successful. Some species of special concern could also be affected.	The alternative would affect >30% Chaco Wash native riparian vegetation, including cottonwood trees. Mitigation measures to offset the adverse effects would be required, extensive, and success of the mitigation measures would not be guaranteed.

Table adapted from NPS, 2003. *Environmental Assessment and Assessment of Effect, Improvements to Park Entrance Road, Mesa Verde National Park.*

### **3.1.1 Soils**

#### **3.1.1.1 Affected Environment**

The alluvial fill sediments exposed in the arroyo walls and present over the arroyo floor are fine-grained and dominated by silty fine sand with trace clay. The NRCS Soil Survey for CCHNP (Zschetzsche, S. and Clark, G., 2004) classifies six soil types for the arroyo environment. The general map unit is the Battlerock-Notal-Beebe-Escawetter. Battlerock and Notal soils are present in the arroyo walls, and are prone to erosion and piping. Beebe and Escawetter are found within the arroyo, Beebe soils supporting tamarisk and a few cottonwoods, while Escawetter soils are found within the inner channel. A soil type similar to Beebe, the Yelives, is also found on floodplains within the arroyo supporting tamarisk and relatively more cottonwoods. The Riverwash soil type may be found in the bottom of the inner channel. These soils are derived chiefly from erosion of the Cliff House Sandstone.

The fine-grained aspect of these soils lends to a vertical weathering profile. This aspect can be observed at many locations along the base of the vertical portions of the arroyo wall, where undercutting has resulted in collapse of portions of the wall, leaving large (10-15 cubic yards) mounds of the silty sand adjacent to the new vertical wall surface (Photograph 3). When the weight of the undercut portion of wall exceeds the soils' cohesive strength, catastrophic bank collapse of that portion (including any archeological sites within the vertical arroyo wall) contributes to sedimentation on the arroyo floor. This fine-grained sand, silt, and clay comprises the majority of the suspended and bedload sediment that is deposited over the arroyo floor during the falling stage of floods.

Erosion of the arroyo walls also proceeds through the mechanism of soil pipes. Soil pipes are subsurface conduits for water flow, that form from ponded water (from rainfall/runoff) in areas adjacent to the arroyo (on the canyon floor) percolating into the underlying soil and flowing along animal burrows, desiccation cracks, and root pathways. Some of the pipes extend hundreds of feet from the Wash. Not all pipes have an outlet into the arroyo, but it is clear that many do. Most of these outlets are in the arroyo walls, perched above the floor of the arroyo. As the pipes enlarge over time the overlying material eventually collapses, forming a small side ravine to the main arroyo (Simons, et al., 1982).

#### **3.1.1.2 Methodology**

Adverse effects to soil were evaluated according to the intensity criteria in Table 3-1.

### **3.1.1.3 Regulation and Policies**

NPS Management Policies (NPS, 2001a) prescribe that any use of off-site soil during construction or repair of sites will make use of soils that will not adversely affect site soils or contaminate other Park resources. Composition of off-site soils must comply with NPS importation procedures and soil parameters (i.e., particle size distribution, free of noxious weeds/seeds, stabilization of emplaced fill and disturbed soils, etc.) so as to match as closely as possible the native soils.

### **3.1.1.4 Soils Impacts of the No-Action Alternative**

**Impact Analysis:** There would be negligible effects upon soil resources other than natural erosion associated with the no-action alternative. The infrequent floods that occur in the arroyo would continue to cause erosion of the arroyo walls along the downstream outside edges of meanders, where the walls are vertical.

**Cumulative Effects:** Previous impacts to soils within the arroyo have included small-scale sedimentation studies involving installation of scour chains, elevation monuments, and test trenches for soil horizon inspection; bridge installation at two points along the Visitor Loop Road also likely had local effects on soils. These activities have had negligible effect on soil fertility and development within the arroyo as a whole.

Previous planting activities in the arroyo have also likely contributed to the development of soils. The exotic tamarisk population is effective in retarding flood-stage flows and its presence has likely affected sedimentation patterns. However, many native woody plants also provide roughness on the arroyo floor, including cottonwoods, sagebrush, rabbitbrush, and willows. Without the presence of the introduced exotic tamarisk, similar soils would likely have developed.

A reasonably foreseeable action within the arroyo is management of the tamarisk. Management would likely include some type of reduction of tamarisk, which will likely have an effect upon flood-stage flow regimes. Such management has not yet undergone extensive hydrologic or NEPA analysis, so the environmental consequences are not clearly understood. Mathematical modeling of sedimentation and erosion trends in response to such dynamic changes is generally acknowledged to be very difficult. At a minimum, information regarding flow velocities under various management scenarios would be helpful in formulating a management strategy that would not exacerbate erosion. Possible effects include no effect, increased erosion, increased sedimentation, and changes in arroyo floor vegetation inventories.

In light of the uncertainty regarding the effect on soils of this introduced exotic species, the cumulative effect of past, present, and future actions in conjunction with the No-Action Alternative is judged to be negligible, with the potential to be minor.

**Conclusion:** The No-Action Alternative would have negligible direct effects upon soils. Erosion of the arroyo walls would continue to supply sediment to the floodplain, and the arroyo floor would continue to aggrade for the foreseeable future. This is a natural process. The long-term effects of arroyo aggradation coupled with a falling water table and management of an introduced exotic species that exerts a strong flow-retarding effect are unknown, and lend uncertainty to cumulative effects analysis. Park resource managers can be expected to adopt a policy that avoids exacerbation of erosion along the arroyo walls. Considering the negligible impact of this alternative, there would be no impairment of soils resources.

#### **3.1.1.5 Soils Impacts of the Preferred Alternative**

**Impact Analysis:** The Preferred Alternative would cause a negligible effect on soils, due to the limited area involved. The measure would involve disturbance to soils and vegetation on the arroyo floor over the length of a temporary road (2,000 feet x 12 feet wide = 24,000 square feet or 0.6 acre) and also involve importation of soil fill, to cover a footprint of approximately 17,500 square feet or 0.4 acre (see Figure 2-1). Due to the localized scope of the project, any effects on soil productivity or fertility would be slight. Mitigation consisting of stabilization would be achieved by re-seeding with native species. In addition to initial irrigation, rooting mats or mulch mats would be used as necessary to ensure seed germination through moisture retention. Beneficial effects on soils would consist of stabilization of arroyo wall soils (Battlerock-Notal complex) and soils in the cut-off chute.

All fill material would be from an approved source, and be certified free of noxious weed seed and non-native plant seed. However, disturbance of the soils would increase the potential for natural noxious weed communities because of their preference for disturbed soils. The noxious weeds would be controlled according to the park's exotic species control plan, which is under development. Use of local sources of fill would decrease the potential for adverse effect associated with fill.

**Cumulative Effects:** The effects of previous and reasonably foreseeable actions upon soils are uncertain, as described above for the No-Action Alternative effects on soils. Cumulative effects are likewise uncertain, but are judged to be negligible due to the small area that would be disturbed.

**Conclusion:** The Preferred Alternative would not adversely affect the fertility of the soil. The effect on soils is determined to be negligible, due to the small area



affected and because mitigation consisting of importation of compatible, weed-free fill material, compaction, and re-vegetation with native plants would likely be successful. Considering the negligible impact of this alternative, there would be no impairment of soils resources.

#### **3.1.1.6 Soils Impacts of Alternative 3**

**Impact Analysis:** Alternative 3 would involve negligible disturbance to soils and vegetation on the arroyo floor over the length of a temporary road (0.6 acres) and also within the jetty fields' footprint (1.8 acres), a total of approximately 2.2 acres (see Figure 2-2). Due to the localized scope of the project, any effects on soil productivity or fertility would be slight. Mitigation consisting of stabilization would be achieved through re-seeding with native species. In addition to initial irrigation of plantings/seeded areas, rooting mats or mulch mats would be used as necessary to ensure seed germination through moisture retention. However, disturbance of the soils would increase the potential for natural noxious weed communities because of their preference for disturbed soils. Weed control during the initial re-vegetation would be employed to mitigate this effect.

**Cumulative Effects:** The effects of previous and reasonably foreseeable actions upon soils are uncertain, as described above for the No-Action Alternative effects on soils. Cumulative effects are likewise uncertain, but are judged to be negligible due to the small area that would be disturbed.

**Conclusion:** Alternative 3 would not adversely affect the fertility of the soil. The effect on soils is determined to be negligible, due to the small area affected and because re-vegetation with native plants would likely be successful. Considering the negligible impact of this alternative, there would be no impairment of soils resources.

### **3.1.2 Floodplains/Waters of the U.S.**

#### **3.1.2.1 Affected Environment**

The affected environment consists of the Chaco Wash floodplain within Chaco Arroyo, within ½ mile upstream and ½ mile downstream from the Pueblo del Arroyo site (Figure 1-2). The floodplain occupies and entirely consists of the generally flat arroyo floor. The arroyo is between 150 and 250 feet in width and 15 to 20 feet deep through the critical reach. The arroyo floor has aggraded appreciably since measurements were first recorded in 1925, from a depth 30 feet below the canyon floor to its present level approximately 17 feet below the canyon floor (Love, D. 1983b).

An un-vegetated inner channel is incised five to seven feet deep in the arroyo floor (Figure 1-2). The inner channel conveys most flows within the Wash. Flow velocity and discharge modeling indicates flows in excess of 1,200 cfs will exceed the average carrying capacity of the channel, leading to flow over the arroyo floor/floodplain (RMC, 2002a).

### **3.1.2.2 Methodology**

Fill material is defined at 33 CFR 323.2(e) as “material used for the purpose of replacing aquatic land with dry land or changing the bottom elevation of any water body”. The geographic extent of non-tidal Waters of the U.S. is defined as the “ordinary high-water mark” (Schneider, C.B. and Sprecher, S.W., 2000).

The ordinary high-water mark at the site has been informally identified as the top of the inner channel bank (personal communication, Ms. Jean Manger, Regulatory Project Manager, USACE Albuquerque District, August 2001). Due to the need for installation of a temporary bridge for crossing the channel at two locations, a 404 permit will be required.

Evaluation of the top of the inner channel banks as the ordinary high water mark is consistent with the regulation definition, i.e., a line established by fluctuations of water and indicated by physical characteristics (33 CFR 329.11(a)(1)). The presence of well-established terrestrial vegetation on the arroyo floor adjacent to the clearly-defined channel, as well as the general character of the Wash (a relatively low-gradient intermittent stream in a semi-arid region) support the determination that water does not typically crest the top of the channel. Under this specification, activities performed on the arroyo floor (exclusive of the inner channel) are not regulated under Section 404 of the CWA. Alternatively, use of a one-year flood water level specification, for which flow does exceed the capacity of the inner channel, would indicate the need for a Section 404 Permit. Formal specification by the Corps (Albuquerque District) will require submittal and review of a Section 404 Permit Application.

### **3.1.2.3 Regulation and Policies**

Placement of fill or dredged material (referred to as “discharge of fill or dredged material”) into the Waters of the U.S. during implementation of erosion control measures (as well as other activities) is regulated by Section 404 of the Clean Water Act (USC 33 1344 et seq., “Permits for dredged or fill material”) and requires a Section 404 Permit (a Corps Permit). Permits are issued according to guidelines developed as authorized by Section 404(b)(1) of the CWA (“Specification of Disposal Sites”). These guidelines are known as the 404(b)(1) Guidelines. The Section 404(b)(1) guidelines are promulgated by the USEPA regulations at 40 CFR

230. USACE also promulgates its own set of Section 404 regulations at 33 CFR 320-330; however, Subpart 320.2(f) of these regulations stipulates that selection of disposal sites will be performed as per the regulations at 40 CFR 230. Many of the key definitions used in 40 CFR 230 are contained in the Corps regulations (33 CFR 320-330) (RMC, 2002b).

Executive Order 11988 (Floodplain Management) directs federal agencies to avoid adverse impacts upon floodplains and their occupants if there is a practicable alternative. The NPS is further directed to take action to reduce the risk of flood loss, to minimize impacts of flooding on human safety, health, and welfare, and to restore and preserve the natural and beneficial values of floodplains. Additionally, the NPS Floodplain Management Guideline outlines NPS procedures for implementing E.O. 11988. This guideline requires that a Statement of Findings documenting consistency with E.O. 11988 be prepared for proposed activities that would result in occupation or modification of floodplains or that would result in impacts to floodplain values (NPS, 1998).

NPS Management Policies with regard to floodplain management require, as much as possible, the use of non-structural measures as much as practicable to reduce hazards to human life and property, while minimizing the impact to the natural resources of floodplains. Management Policies also require the Park to manage streams as entire hydrologic units, and to protect stream processes that create habitat features such as floodplains, riparian systems, woody debris accumulations, terraces, gravel bars, riffles, and pools. Stream processes include flooding, stream migration, and associated erosion and deposition. NPS Management Policies also require that protection of watershed and stream features be accomplished primarily by avoiding impacts to watershed and riparian vegetation, and by allowing natural fluvial processes to proceed unimpeded. When conflicts between infrastructure and stream processes are unavoidable, NPS managers will first consider relocating or redesigning facilities, rather than manipulating streams. Where stream manipulation is unavoidable, managers will use techniques that are visually non-obtrusive and that protect natural processes to the greatest extent practicable.

#### **3.1.2.4 Floodplains/Waters of the U.S Impacts of the No-Action Alternative**

There would be negligible effect upon floodplains or Waters of the U.S. as a result of the no-action alternative. This is because there would be no activity on the floodplain or in the inner channel. The No-action alternative would not result in loss of wetlands, compromise floodplain values or processes, or involve permanent placement of fill in waters of the U.S. Accordingly, there would be no cumulative effects. There would be no impairment of park resources or values with regard to floodplains or waters of the U.S.

### 3.1.2.5 Floodplains/Waters of the U.S Impacts of the Preferred Alternative

**Impact Analysis:** There would be negligible effects upon Waters of the U.S. posed by the Preferred Alternative. A temporary culvert and soil fill would be directly placed in the existing waterway (the inner channel) below the typical high-water mark to allow crossing of the channel at two locations. The typically low flows that occur in the wash during the winter months would pass through the temporary culvert.

The preferred alternative would have negligible impact on floodplain values or processes. Changes to flood-stage flow processes would be minimal, since fencing and fill would be installed along the arroyo wall, minimizing any obstruction to flow. Damage to existing large woody vegetation would be avoided. Construction-related effects on the arroyo floor/floodplain would be temporary. Applicable Section 404 floodplain management guidelines (40 CFR 230) would be followed as appropriate, such as restoration of the floodplain (i.e., re-vegetation of disturbed soil areas) to its natural state as much as possible.

Detailed hydrologic modeling performed using the U.S. Army Corps of Engineers HEC-RAS software (RMC, 2002a) for the initially proposed revetment (see Section 1.6) indicate that the addition of fill along the arroyo wall and filling of the cut-off chute would result in flow velocity increases within the channel and over the floodplain through the 700-foot portion of arroyo immediately upstream from Pueblo del Arroyo, but these increases would dissipate to ambient values as floodwater rounded the soil island on the south side of the chute. The revetment geometry modeled for the revetment at Pueblo del Arroyo involved greater constriction of the arroyo upstream from Pueblo del Arroyo than the preferred alternative, and also included the filling of the chute. Accordingly, the results are judged to represent hydraulic consequences slightly more severe than would be caused by the preferred alternative.

**Cumulative Effects:** As described above, previous erosion control activities in the arroyo have included planting of cottonwoods, willow, and tamarisk. These activities have likely contributed to the development of the floodplain and floodplain processes, although the degree is uncertain. Native plant species may have developed and propagated on the floodplain without planting, once livestock grazing was discontinued in the Park. The main difference between native woody vegetation and tamarisk is that tamarisk grows taller, in some cases taller than the arroyo walls. This aspect lends to a greater flow-retarding effect.

A reasonably foreseeable action within the arroyo is management of the tamarisk. Management would likely include some type of reduction of tamarisk, which will likely have an effect upon flood-stage flow regimes. Such management has not yet

undergone extensive hydrologic or NEPA analysis, so the environmental consequences are not clearly understood.

While the effects upon the arroyo floodplain from previous and future actions are difficult to evaluate definitively, they appear to range from minor to moderately beneficial. Development of a vegetated floodplain has reduced flow velocities and associated erosion. Management of tamarisk would help in restoring floodplain vegetation to a more native condition.

The preferred alternative would have a negligible effect on floodplain processes or values. Therefore, there would be no cumulative adverse effect upon the floodplain or the Waters of the U.S. posed by the preferred alternative in conjunction with previous and future actions.

**Conclusion:** The effect upon floodplains and/or waters of the U.S. would be negligible under the preferred alternative. The minor adverse effect caused by two temporary channel crossings would be temporary, lasting only as long as construction (estimated at 12 to 18 weeks). The preferred alternative protects cultural properties from flood-related damage by unobtrusively controlling erosion with minimal effect on stream processes or floodplain values. The preferred alternative would not contribute to cumulative effects. Considering the negligible impact of this alternative, there would be no impairment of floodplain resources.

### **3.1.2.6 Floodplains/Waters of the U.S Impacts of Alternative 3**

**Impact Analysis:** There would be negligible impact to the stream processes or Waters of the U.S. (i.e., flows within the inner channel) under Alternative 3. Alternative 3 involves installation of approximately 2 acres of jetty fields on the floodplain at Pueblo del Arroyo. A temporary culvert and soil fill would be directly placed in the existing waterway below the typical high-water mark to allow crossing of the channel at two locations. The low flows from snow melt that occur in the wash during the winter would pass through the temporary culvert. Any increases in suspended sediment from the temporary channel crossings would be negligible in comparison to the typically high suspended sediment loads in the wash.

A localized minor adverse effect on floodplain values and processes would result from installation of the three jetty fields over a total of 1.8 acres. The jetties would constitute an artificial structural addition to the floodplain, which would not be in keeping with the management policy that stipulates flood control structures, if absolutely necessary, be as unobtrusive as possible (NPS, 2001a). These jetty fields would also cause a local increase in the roughness of the floodplain, diverting high-velocity flow away from the edges, towards the middle. This effect would constitute a local change in (flood-stage) stream processes, contrary to NPS management policy. However, these effects would be localized in terms of the

entire arroyo floodplain, and would also protect cultural properties from damage. Hydrologic modeling (RMC, 2002a) has shown that such localized constrictions of the arroyo produce similarly localized effects that dissipate immediately downstream to the normal flow condition.

**Cumulative Effects:** Previous erosion control activities affecting the floodplain and/or Waters of the U.S. have apparently resulted in beneficial effects with regard to controlling flood-stage flows, as described above. Several small-scale research activities have had negligible effect. Future efforts in exotic plant reduction could have minor to moderate temporary adverse effects on floodplain processes, although the long-term effect would be beneficial, assuming that mitigation such as replacement with native woody vegetation occurred. Ultimately a reduction in tamarisk may slow the alluvial aquifer water table decline. Future inventorying and monitoring of floodplain components are expected to have negligible effect.

Since the effect of Alternative 3 would be a minor adverse effect on the floodplain values, the cumulative effect on the floodplain in conjunction with past and reasonably foreseeable erosion control actions would be a very slight degradation of the floodplain values overall. This small negative cumulative effect is judged to be negligible to minor in intensity.

**Conclusion:** Alternative 3 would cause negligible-to-minor adverse impacts to the floodplain and negligible adverse effects regarding waters of the U.S. Locally, the jetty fields would constitute an obtrusive addition to the floodplain, and affect flood-stage flow processes locally to a small degree. Cumulative effects of Alternative 3 in conjunction with previous, current and future actions would be negligible to minor. Considering the minor localized impact of this alternative, there would be no impairment of floodplain resources.

### **3.1.3 Vegetation**

#### **3.1.3.1 Affected Environment**

The entire arroyo reach within the park boundaries comprises 485.94 acres (196.65 hectares) of riparian environment (Floyd-Hanna et al., 1995). Woody vascular vegetation within the riparian environment in the site area consists of broadleaf cottonwood, sagebrush, greasewood, tamarisk, four-winged saltbush, and sparse willows. Mature cottonwoods and tamarisk comprise the predominant large woody vegetation. Sagebrush is present in scattered groves, often interspersed with tamarisk. Other floodplain vegetation includes rabbitbrush, greasewood, snakeweed, and grasses including invasive cheatgrass. Chokecherry, currant, squawberry, and three-leaf sumac have been observed in sheltered locations, where moisture is slightly more available (Potter et al., 1980).

Cottonwoods (*Populous sp.*) are native to Chaco Wash, but do not readily propagate due to the sporadic water quantity or availability (Pendale, in progress).

It is reported that many of the seedlings planted by NPS did not survive due to drought conditions (Simons et al., 1982) although new recruitment does occur along the wash banks (Malde, H., 2000).

Except in the inner channel, woody vascular vegetation has been augmented by the development of a grassy floor over most of the arroyo bottom. Although local soil scour occurs in the wash, sedimentation has become the predominant process, due to flow drag from vegetation, especially the extensive tamarisk thickets (Vincent, K., in progress).

### **3.1.3.2 Methodology**

An inventory was performed of the woody vascular vegetation present in the critical reach. Vegetation inventoried includes tamarisk/sagebrush thickets, cottonwood trees individually and in large groups, and willows where present. A GIS database was prepared to document the inventory. Each data entry in the database includes the GPS location coordinates and a digital photograph of each vegetation feature mapped. Conceptual design plans and drawings were prepared to assess the best arroyo access route, i.e., one that would involve the minimum adverse impact to woody vascular vegetation in the arroyo and also avoid cultural sites (RMC, 2002c). Temporary impacts to grass cover on the arroyo floor where construction machinery access would be established are considered to be unavoidable. Native grass cover would be re-established following construction by re-seeding and through the use of seeding mats to control erosion until the grass was re-established.

### **3.1.3.3 Regulation and Policies**

NPS Management Policies (NPS, 2001a) require maintenance of all native plant communities as part of the natural ecosystems of parks. This maintenance includes preservation and restoration of natural abundances, diversities, dynamics, distributions, habitats, and behaviors of native plant and animal populations and the communities and ecosystems in which they occur. Management policies also require minimization of human impacts on native plant populations, communities, and ecosystems, and the processes that sustain them. When plants are removed, such removals will not cause unacceptable impacts to native resources, natural processes, or other park resources.

#### **3.1.3.4 Vegetation Impacts of the No-Action Alternative**

**Impact Analysis:** The no-action alternative would have negligible effect on vegetation present in the arroyo. This is because there would be no disturbance of vegetation in the project area. The project area comprises less than 3 percent of the total area of riparian vegetation within the park.

**Cumulative Effects:** As described above under Waters of the U.S./Floodplain impacts, previous activities in Chaco Wash have involved extensive planting of cottonwood, willow, and tamarisk. Vegetation introduced to the arroyo by planting and by natural recruitment has become well-established in the last 50 years. The introduction of the exotic species *tamarix pentandra* (tamarisk) has had a moderate adverse effect upon overall riparian vegetation. Also a future Park project that may affect vegetation within the arroyo is reduction/removal of the exotic plant *tamarix pentandra*. Once tamarisk is controlled this species would be replaced with other arborous native species, leading to an overall beneficial effect within Chaco Wash.

Since the No-Action Alternative would have a negligible effect on floodplain vegetation, cumulative effects posed by the No-Action Alternative in conjunction with previous and future activities would also be negligible.

**Conclusion:** The No-Action Alternative would result in negligible impacts to vegetation in the project area. Accordingly the No-Action alternative would not contribute to cumulative effects upon vegetation when considered in conjunction with past, current and future planned actions. Considering the negligible effect of the No-Action Alternative, there would be no impairment of vegetation resources.

#### **3.1.3.5 Vegetation Impacts of the Preferred Alternative**

**Impact Analysis:** The Preferred Alternative would cause negligible impacts to vegetation in the project area. Approximately 2,000 feet of temporary roadway would be established on the arroyo floor (1,500 feet) and the canyon floor (500 feet), to facilitate transport of soil fill and materials to the appropriate locations. Large woody vegetation disturbance would be avoided when establishing the temporary road. The road surface would simply be the soil of the arroyo; no artificial surfacing would be used. These roadways would disturb less than one percent of existing non-cottonwood riparian vegetation and less than one percent of canyon floor vegetation. Vegetation that would be affected consists of grasses and other small plants that re-vegetate relatively rapidly. All disturbances would be mitigated by active re-vegetation.

**Cumulative Effects:** As described above, previous and reasonably foreseeable actions in the arroyo pose both adverse and beneficial effects throughout the



vegetated arroyo. Under the Preferred Alternative, effects upon vegetation within the project area would be negligible, and therefore would not cumulatively affect vegetation when considered in conjunction with other past, present and future actions.

**Conclusion:** Effects upon vegetation would be negligible under the preferred alternative. Localized disturbances of grasses and small non-woody vegetation would be mitigated through re-vegetation efforts. There would be no cumulative effects upon vegetation posed by the preferred alternative in conjunction with past, current and reasonably foreseeable actions. Considering the negligible effect of the Preferred Alternative, there would be no impairment of vegetation resources.

### **3.1.3.6 Vegetation Impacts of Alternative 3**

Impact Analysis: Impacts to the vegetation within the arroyo would be negligible under Alternative 3. Initial disturbance to vegetation on the arroyo floor would be limited to approximately 1,000 feet of temporary road and two (2) acres of the arroyo floor where the jetty fields would be installed. Damage to large woody plants such as cottonwoods, sagebrush, and tamarisk would be avoided. Impacts to vegetation over this area would be short term, with grasses becoming re-established within three years. An additional 500 feet of temporary road would be established on the canyon floor northwest of Pueblo del Arroyo, to facilitate construction of jetty field C. These roadways would disturb less than one percent of existing non-cottonwood riparian vegetation and less than 0.1 percent of canyon floor vegetation. All disturbed vegetation would re-seeded or re-planted. Re-establishment of vegetation would be encouraged through the use of a temporary shallow irrigation well.

Cumulative Effects: As described above for Alternatives 1 and 2, previous and planned activities concerning vegetation in the arroyo have apparently resulted in a combination of adverse and beneficial effects, although the overall effect is hard to judge. Alternative 3 would have a negligible effect on vegetation, therefore there would be no cumulative effects.

Conclusion: Alternative 3 would have a negligible effect on native vegetation in the project area. Disturbance of soils and non-woody vegetation would be temporary, with the native grasses recovering within three years. There would be no cumulative effects upon vegetation posed by Alternative 3 in conjunction with past, current and reasonably foreseeable actions. Considering the negligible effect of the Preferred Alternative, there would be no impairment of vegetation resources.

## 3.2 Cultural Resources

Cultural Resources considered in this EA include Archaeological Resources, Historic Structures/Cultural Landscapes, and Ethnographic Resources. Cultural resources are a major component of the environment at CCNHP. National historic sites, national historical parks, and other parks significant primarily for their cultural resources are entered automatically in the National Register of Historic Places (NRHP) upon establishment. Chaco Culture NHP's national and international significance is based on its more than 4,000 prehistoric and historic archaeological sites, representing more than 10,000 years of human cultural history in Chaco Canyon (NPS, 1998). The significance of the historic context is related to the pre-historic development of the area of Chacoan influence by ancestral Puebloan people, and also to the Chacoan architectural style that is evidenced in the great house structures (NRHP Bulletin 15, *How to Apply the National Register Criteria for Evaluation*). Further, CCNHP cultural properties possess outstanding universal value to humanity and have qualified for World Heritage List designation. CCNHP was listed as a UNESCO World Heritage Site in 1987.

Numerous archaeologists have performed research and documented the cultural resources of CCNHP and the Chaco culture in general (Judge, J., 2004). A report was published on the National Geographic Society excavations that took place in the 1920s (Judd, N.M., 1959). There are numerous published and non-published archaeological studies, maps, photographs, and other records curated in the archaeological site files and the Chaco Collection archives. Recently a Historic Structures Report was prepared to provide thorough documentation of the exposed portions of Pueblo del Arroyo in a published format (Crosby, A., 2004, *Draft*). All preservation treatments and architectural documentation records are compiled in the Chaco Collection archives. These archival records serve to document the architectural and archaeological values of Pueblo del Arroyo, should a flood event damage exposed portion of the structure.

It must be assumed that a major precipitation event commensurate with the theoretical 100-year event will occur at some point in time, and associated runoff within Chaco Wash will be commensurate with that modeled for the 100-year event. Even the 50-year event has been predicted to yield floods of sufficient stage to impinge on the arroyo walls, potentially leading to cultural resource-damaging erosion of the arroyo walls (Simons et al., 1982; RMC, 2002a).

In addition to the highly visible great house structures, Park archaeologists and other researchers have identified and documented numerous smaller archaeological sites distributed throughout the canyon floor. These resources range from large habitations and small houses to pre-historic camps, artifact concentrations, buried walls, earthen platforms, road segments, irrigation systems, and shrines. These unexcavated sites represent a storehouse of anthropological

information. Certain sites are exposed in the arroyo walls throughout the length of Chaco Wash. Beyond the exposed physical remains the detailed nature of some sites is unknown, and will remain so until they can be studied appropriately.

Adherence to minimum safe distances from Pueblo del Arroyo for operation of equipment that may be used during any of the active alternatives considered would further protect the standing masonry walls (architecture) of the structure from inadvertent impacts (Figures 2-8 and 2-9). The vibration study was conducted using various types of construction equipment (see section 2.3.2) and calibrated horizontal accelerometers located throughout the structure (King, 2001). The site would be monitored by an archaeologist during all construction activities. The preferred alternative is considered the alternative that would provide the greatest protection to the site while causing the least impact to the cultural landscape and surrounding sites.

### **3.2.1 Methodology for Cultural Resource Effects Determinations**

Impact analyses or assessments of effect are intended to comply with the requirements of both the National Environmental Policy Act and Section 106 of the National Historic Preservation Act (Section 106).

In accordance with the Advisory Council on Historic Preservation's regulations implementing Section 106 of the National Historic Preservation Act (36 CFR Part 800, Protection of Historic Properties), impacts to cultural resources were identified and evaluated by:

- Determining the area of potential direct and indirect effects;
- Identifying cultural resources present in the area of potential effects that are either listed in or eligible to be listed in the NRHP;
- Applying the criteria of adverse effect to affected resources either listed in or eligible to be listed in the NRHP; and
- Considering ways to avoid, minimize or mitigate adverse effects.

Under the Advisory Council's regulations, a Section 106 determination of either *adverse effect* or *no adverse effect* must also be made for affected historic properties. The criteria of adverse effect is defined at 36 CFR Part 800.5, *Assessment of Adverse Effects*:

Criteria of adverse effect: An adverse effect is found when an undertaking may alter, directly or indirectly, any of the characteristics of a historic property that qualify the property for inclusion in the NRHP in a manner that would diminish the integrity of the property's location, design, setting, materials, workmanship, feeling, or association.

Under Section 106 criteria an *adverse effect* occurs whenever an impact alters, directly or indirectly, any characteristic of a cultural resource that qualifies it for inclusion in the NRHP. For example, this could include diminishing the integrity of the resource's location, design, setting, materials, workmanship, feeling, or association.

Adverse effects also include reasonably foreseeable effects that would occur later in time, be farther removed in distance, or be cumulative as a result of a given action. Under Section 106 criteria a determination of *No adverse effect* means there is an effect, but the effect would not diminish in any way the characteristics of the cultural resource that qualify it for inclusion in the NRHP (NPS, 2003).

In addition to Section 106 determinations of adverse effect according to the criteria regarding NRHP eligibility, Council on Environmental Quality (40 CFR 1508.27) regulations that implement the National Environmental Policy Act require that impacts to historic structures/cultural landscapes are described in terms of context and intensity. Director's Order 12 (DO #12: NPS, 2001b) requires that considerations of the duration and timing of the effects (direct or indirect) of the action be incorporated into the impact analysis. Definitions of intensity of impacts to cultural resources are summarized in Table 3-2. In general the context of this site-specific action with regard to cultural resources is localized at the Pueblo del Arroyo area of potential effect, defined as a 4000 by 4000-foot square area centered on the structure.

Council on Environmental Quality regulations (CEQ 1978) and *Director's Order #12 and Handbook: Conservation Planning, Environmental Impact Analysis, and Decision Making* (NPS, 2001b) call for a discussion of the appropriateness of mitigation, as well as an analysis of how effective the mitigation would be in reducing the intensity of a potential effect, such as reducing the intensity of an impact from major to moderate or minor. Any resulting reduction in intensity of impact by mitigation, however, is an estimate of the effectiveness of mitigation under the National Environmental Policy Act only. It does not suggest that the level of effect as defined by Section 106 is similarly reduced. Although adverse effects under Section 106 may be mitigated, the effect remains adverse.

A Section 106 summary is included in each impact analysis for cultural resources. The summary is intended to meet the requirements of Section 106 and is an assessment of the effect of implementing the alternative on cultural resources, based on the criteria of effect and adverse effect found in the Advisory Council's regulations.

### **3.2.2 Regulation and Policies**

Section 106 of the National Historical Preservation Act requires the Park Service to consider the effects of projects on properties listed or eligible for listing on the National Register of Historic Properties (NRHP). The Advisory Council on Historic Preservation regulations (36 CFR Part 800) describe the procedures by which consideration of the effects of a project should be carried out. Consultation with State Historic Preservation Offices is a key component, as is public participation.

NPS Management Policies stipulate that:

“The Park Service will provide for the long-term preservation of, public access to, and appreciation of, the features, materials, and qualities contributing to the significance of cultural resources. With some differences by type, cultural resources are subject to several basic treatments, including (1) preservation in their existing states; (2) rehabilitation to serve contemporary uses, consistent with their integrity and character; and (3) restoration to earlier appearances by the removal of later additions and replacement of missing elements. Decisions regarding which treatments will best ensure the preservation and public enjoyment of particular cultural resources will be reached through the planning and compliance process, taking into account:

- The nature and significance of a resource, and its condition and interpretive value;
- The research potential of the resource;
- The level of intervention required by treatment alternatives;
- The availability of data, and the terms of any binding restrictions; and
- The concerns of traditionally associated peoples and other stakeholders.”

NPS Management Policies also provide that “archaeological resources will be left undisturbed unless removal of artifacts or intervention into fabric is justified by protection, research, interpretive, or development requirements.” If proposed activities will have an effect on archaeological resources, “all reasonable measures to limit adverse effects will be taken, including recovery of data and salvage of materials, as appropriate.” (Director’s Order 28: NPS, 1998c)).

Archeological data recovery is permitted if justified by research or interpretation needs. Significant archeological data that would otherwise be lost as a result of resource treatment projects or uncontrollable degradation or destruction will be recovered in accordance with appropriate research proposals and preserved in park museum collections. Data will be recovered to mitigate the loss of significant archeological data due to park development, but only after:

- the redesign, relocation, and cancellation of the proposed development have all been considered and ruled out as infeasible through the planning process;
- the park development has been approved; and the project has provided for data recovery, cataloging, and the initial preservation of recovered collections.

With regard to erosion threats to archaeological resources, Management Policies indicate that “Archeological resources subject to erosion, slumping, subsidence, or other natural deterioration will be stabilized using the least intrusive and destructive methods. The methods used will protect natural resources and processes to the maximum extent feasible. Stabilization will occur only after sufficient research demonstrates the likely success of the proposed stabilizing action, and after existing conditions are documented.” (NPS Management Policies, 2001a).

The Advisory Council on Historic Preservation regulations (36 CFR 800.1-13) stipulate that for the purposes of Section 106 compliance the following definition of adverse effect be used:

1) Criteria of adverse effect: An adverse effect is found when an undertaking may alter, directly or indirectly, any of the characteristics of a historic property that qualify the property for inclusion in the NRHP in a manner that would diminish the integrity of the property's location, design, setting, materials, workmanship, feeling, or association. Consideration shall be given to all qualifying characteristics of a historic property, including those that may have been identified subsequent to the original evaluation of the property's eligibility for the NRHP. Adverse effects may include reasonably foreseeable effects caused by the undertaking that may occur later in time, be farther removed in distance or be cumulative.

2) Examples of adverse effects: Adverse effects on historic properties include, but are not limited to:

- (i) Physical destruction of or damage to all or part of the property;
- (ii) Alteration of a property, including restoration, rehabilitation, repair, maintenance, stabilization, hazardous material remediation, and provision of handicapped access, that is not consistent with the Secretary's standards for the treatment of historic properties (36 CFR part 68) and applicable guidelines;
- (iii) Removal of the property from its historic location;
- (iv) Change of the character of the property's use or of physical features within the property's setting that contribute to its historic significance;
- (v) Introduction of visual, atmospheric or audible elements that diminish the integrity of the property's significant historic features;
- (vi) Neglect of a property which causes its deterioration, except where such neglect and deterioration are recognized qualities of a property of religious and cultural significance to an Indian tribe or Native Hawaiian organization; and
- (vii) Transfer, lease, or sale of property out of Federal ownership or control without adequate and legally enforceable restrictions or conditions to ensure long-term preservation of the property's historic significance.

**Table 3-2**  
**NEPA And Section 106 (NHPA)**  
**Cultural Resources Effects Definitions**

	<b>Negligible</b>	<b>Minor</b>	<b>Moderate</b>	<b>Major</b>
<p><b>Cultural Resources</b></p> <p><i>Short-term – effects on the natural elements of a cultural landscape may be comparatively short-term (e.g., 3 to 5 years) until new vegetation grows or historic plantings are restored.</i></p> <p><i>Long-term - Because most cultural resources are nonrenewable, any effects on archeological, historic, or ethnographic resources, and on most elements of a cultural landscape, would be long-term.</i></p>	<p>Effects would be at the lowest levels of detection - barely perceptible and not measurable. For section 106 purposes, the determination would be <i>no adverse effect</i>.</p>	<p><b>Adverse effect —</b> the action would not affect the character-defining patterns and features of a site or cultural landscape eligible for listing or listed on the National Register of Historic Places (NRHP). For section 106 purposes, the determination of effect would be <i>no adverse effect</i>.</p> <p><b>Beneficial effect —</b> preservation of character defining patterns and features in accordance with the <i>Secretary of the Interior's Standards for the Treatment of Historic Properties With Guidelines for the Treatment of Cultural Landscapes</i>. For section 106 purposes, the determination of effect would be <i>no adverse effect</i>.</p>	<p><b>Adverse effect —</b> the action would alter a character-defining pattern(s) or feature(s) of the site or cultural landscape but would not diminish the integrity to the extent that its NRHP eligibility would be jeopardized. For section 106 purposes, the determination of effect would be <i>adverse effect</i>.</p> <p><b>Beneficial effect —</b> rehabilitation of a site or landscape or its patterns and features in accordance with the <i>Secretary of the Interior's Standards for the Treatment of Historic Properties With Guidelines for the Treatment of Cultural Landscapes</i>. For section 106 purposes, the determination of effect would be <i>no adverse effect</i>.</p>	<p><b>Adverse effect —</b> the action would alter a character-defining pattern(s) or feature(s) of the site or cultural landscape, diminishing the integrity to the extent that it no longer would be eligible for listing on the NRHP. For section 106 purposes, the determination of effect would be <i>adverse effect</i>.</p> <p><b>Beneficial effect -</b> restoration of a site or landscape or its patterns and features in accordance with the <i>Secretary of the Interior's Standards for the Treatment of Historic Properties With Guidelines for the Treatment of Cultural Landscapes</i>. For section 106 purposes, the determination of effect would be <i>no adverse effect</i>.</p>

Table adapted from NPS, 2003. *Sample Impact Threshold Definitions And Methodology Sections*. National Park Service U.S. Department of the Interior, Intermountain Support Office, Denver. August 14, 2003.

### 3.2.3 Archaeological Resources

Archaeological resources include recognized or undiscovered resources that provide evidence of historic and pre-historic human activity. While archaeological resources may include structures, the Pueblo del Arroyo great house is treated in this EA as another of the other recognized classes of cultural resources, i.e., Structures, and effects on the great house are addressed in a separate section (Section 3.2.3), Historic Structures and Cultural Landscapes. Using this convention, archaeological resources considered in this EA consist of largely unexamined sites exposed in the arroyo walls such as smaller roomblocks, historic roomfill dumps, and cultural lenses.

#### 3.2.2.1 Affected Environment

The area of potential effect is defined as a 4,000 x 4,000-foot square area centered on Pueblo del Arroyo, the sides of which are oriented parallel to the four directions of the compass. This area encompasses Chaco Wash from the Pueblo Bonito Bridge (immediately south of the Pueblo Bonito great house), downstream past Pueblo del Arroyo to the Kin Kletso structure. In addition to the great house structures there are several smaller NRHP-eligible archaeological sites located along the edges of the arroyo. These include several buried sites exposed by arroyo wall erosion located immediately up- and downstream from the great house on both sides of the arroyo. These arroyo wall sites have been exposed by erosion, and extend away from the arroyo walls beneath the canyon floor. An inventory of the arroyo wall sites located in the area of potential effect is included in Appendix A.

#### 3.2.2.2 Archaeological Resource Impacts of the No-Action Alternative

**Impact Analysis:** Direct effects on archaeological sites exposed in the arroyo wall within the area of potential effect would be negligible under the no-action alternative. Such effects would not be realized until a large-scale flood event causes sufficient erosion to undermine these sites (i.e., the No-Action Alternative would result in indirect adverse effects, that would be long-term). With regard to context, it should be noted that the intent of the project is to protect Pueblo del Arroyo from erosion, not these sites. There are numerous such sites throughout the length of Chaco Wash.

However, indirect long-term adverse impacts would likely include damage to two small archaeological sites exposed along the arroyo wall adjacent to Pueblo del Arroyo. Also, three other NRHP-eligible sites located (within the area of potential effect) on the opposite side of the arroyo from Pueblo del Arroyo would undergo



long-term moderate adverse effects under the no-action alternative. Due to the generally long intervals between such flooding, and the development of floodplain vegetation that has occurred over the last 50 years, it is difficult to predict whether or not arroyo wall damage will occur during such flooding. The determination of adverse impact is based on the assumption that with no action, eventually a flood will cause erosion at these sites sufficient to undermine the arroyo wall. The adverse effect at these sites would be moderate (see Table 3-2 Cultural Resource Effects Definitions above).

**Cumulative Effects:** Previous erosion control activities in Chaco Wash (see discussion above in Section 3.1.4.5) have had a beneficial effect protecting the arroyo wall from erosion, and as a result have also protected the archaeological sites located in the vertical arroyo walls. In the area of potential effect, however, three archaeological sites exposed in the arroyo wall are located along the downstream, outside edge of arroyo meanders (29SJ823, 29SJ1119, and 29SJ674) and there is currently little to no protective vegetation adjacent to two of these (29SJ823 and 29SJ674). In this respect, previous erosion control actions have had only a minor beneficial effect with regard to preservation of these sites, in that flow velocities have been reduced overall, but the sites are still at risk of damage due to their specific location and context. Cumulative effects of previous and reasonably foreseeable erosion control in conjunction with the indirect effects of the no-action alternative would constitute a net adverse effect, chiefly attributable to the effects (continued erosion of the arroyo walls) of the no-action alternative. There are currently no plans to implement erosion control within the arroyo to preserve the numerous small archaeological sites exposed in the arroyo wall.

**Conclusion:** The no-action alternative for erosion control to protect Pueblo del Arroyo from damage poses an indirect moderate adverse effect on the small archaeological sites exposed in the arroyo wall within the area of potential effect. Flood-stage flows may be expected to lead to damage by removing some soil from beneath certain of these sites, due to their locations. These moderate adverse effects would be long term, and can be expected to occur at any time within the next 100 years, depending on the timing of a truly large flood. Cumulative effects of the No-Action Alternative in conjunction with previous and reasonably foreseeable actions are also adverse, and moderate in intensity.

**Section 106 Determination:** The Section 106 determination for the no-action alternative on Archaeological Resources exposed in the arroyo wall within the area of potential effect is *adverse effect*. This determination is due to indirect effects in the form of erosion-related damage to these sites.

### 3.2.2.3 Archaeological Resource Impacts of the Preferred Alternative

**Impact Analysis:** The Preferred Alternative would result in a direct long-term moderate beneficial effect through preservation of two small eligible archaeological sites (29SJ1119 and 29SJ674) and one small dumpsite (not recorded as eligible), which are exposed in the arroyo wall. The arroyo wall at these sites would be stabilized by installation of cable-rail fencing. Additionally, a small outlying wall structure located on the soil island that forms one side of the cut-off chute would be preserved to some degree by virtue of stabilization associated with placing fill in the chute. This feature would be first covered with geotextile fabric to aid in potential future identification if necessary.

Indirect long-term effects upon archaeological resources would be negligible. Hydrologic modeling has shown that while local constrictions of the arroyo results in increased velocity and water depth relative to the existing condition (potentially leading to increased erosion), the increases are very small and dissipate immediately downstream from the constriction (RMC, 2002a). The Preferred Alternative would constrict the arroyo minimally, in that filling of the chute would not constrict the main arroyo width.

**Cumulative Effects:** As discussed above, previous erosion control activities in Chaco Wash have apparently had an overall moderate beneficial effect with regard to protecting the arroyo walls from erosion, and as a result also protecting the archaeological sites exposed at various locations along the arroyo walls from damage. In the area of potential effect, the effect has been minor due to the specific location of several of these sites.

Under the preferred alternative, beneficial effects include stabilization of the arroyo wall adjacent to Pueblo del Arroyo and also, through mitigation measures, to other sites within the area of potential effect that are judged to be at risk. This would contribute a moderate beneficial effect to these sites. The cumulative effect of the preferred alternative in conjunction with the beneficial effect posed by previous actions would be an overall moderate beneficial effect upon archaeological sites within the area of potential effect.

**Conclusion:** The preferred alternative would have a direct long-term moderate beneficial effect upon eligible archaeological sites within the area of potential effect. Placement of fencing and fill within the cut-off chute and along the arroyo wall to half-height would stabilize the arroyo wall and the archaeological sites while still allowing study to be performed at the sites. The cumulative effect upon archaeological resources within the project area of the Preferred Alternative in conjunction with previous and reasonably foreseeable actions would be a moderate beneficial effect. Considering the beneficial effect, there would be no impairment of archaeological resources.

**-Section 106 Determination:** The Pueblo del Arroyo complex archaeological sites present in the arroyo wall within the project area would be stabilized and preserved. The Section 106 determination for Archaeological Resources for the preferred alternative is *no adverse effect*.

#### **3.2.2.4 Archaeological Resource Impacts of Alternative 3**

**Impact Analysis:** Alternative 3 would cause an indirect long-term minor to moderate beneficial effect upon archaeological sites within the project area. The risk of erosion-related damage to two NRHP-eligible sites and one potentially eligible site (described above in Section 3.2.2.3) would be reduced as a result of the flow-retarding qualities afforded by the jetty fields. Reduced flow velocities adjacent to the arroyo wall at these locations would enhance sedimentation, eventually stabilizing the arroyo wall. Thus alternative would not afford direct protection these small sites from the effects of a 100-year flood event, but is likely to reduce the risk of damage.

**Cumulative Effects:** In addition to the minor beneficial effects (preservation) caused by previous erosion control activities within the arroyo (see Floodplain Impacts, discussed above), Alternative 3 would result in a minor beneficial effect upon three small archaeological sites in the project area. Accordingly, Alternative 3 in conjunction with previous, current, and reasonably foreseeable actions would result in a cumulative beneficial effect.

**Conclusion:** Alternative 3 would pose an indirect minor beneficial effect on archaeological resources, by reducing the risk of erosion-related damage to several sites within the area of potential effect from 50- to 100-year floods. Also, the effects of Alternative 3 in conjunction with previous, current, and reasonably foreseeable actions would result in a cumulative beneficial effect. Considering the beneficial effect, there would be no impairment of archaeological resources.

**-Section 106 Determination:** The risk of erosion-related damage at two eligible sites located in the arroyo wall slightly downstream from jetty field A (29SJ1119 and 29SJ674) would be reduced. The Section 106 determination for Archaeological Resources for the Alternative 3 is *no adverse effect*.

#### **3.2.3 Historic Structures/Cultural Landscapes**

Accenting the desert landscape of Chaco Canyon are the striking architectural remains of the Chacoan great houses present on the canyon floor. The desert landscape is mostly undeveloped except for the Visitor Loop Road, and the perimeter fencing is unobservable from most of the areas typically visited by the public. The tan-colored north wall of the canyon, rising 80 to 100 feet from the

canyon floor, provides an omnipresent backdrop to most of the architectural sites within the canyon, while the steep slopes of the mesas that form the south edge of the canyon are interrupted by South Gap just south of the project site. A generally flat-lying desert plain extends to the south (Photograph 4); on clear days Mount Taylor is visible on the horizon.

The great houses or pueblo structures present on the canyon floor, constructed of native sandstone and mud mortars, and so blending closely in color with the surrounding area, provide dramatic punctuation to the natural lines of the landscape. The massive walls with intricately patterned lithic-masonry faces and large open cylindrical kivas that are present in many of the structures contribute to the composition of a complex and vast cultural landscape.

### **3.2.3.1 Affected Environment**

The cultural landscape of the Pueblo del Arroyo area of CCNHP is fairly unique in the U.S., and occupies the center of the Chacoan sphere of influence. It is principally an ethnographic landscape as defined by the Cultural Resource Management Handbook (Director's Order 28), by virtue of the Park area being a cultural center with ties to multiple, long-established Native American tribes and Pueblos in the Southwest. The cultural landscape of the Park cannot be underestimated, as it comprises the core body of evidence and information regarding the Chacoan culture.

The project area cultural landscape generally comprises an area of one square-mile radius around Pueblo del Arroyo, although the desert landscape extends for many miles beyond this area. This area of one-mile radius encompasses the viewshed that is experienced from Pueblo del Arroyo, and forms the core of the viewshed experienced from the overlook point on the Pueblo Alto Trail, as shown in Photograph 4. It also includes the other two great house structures, Pueblo Bonito and Kin Kletso, which make up the "canyon core" complex.

The landscape is only minimally developed with the Visitor Loop Road and Pueblo Bonito Bridge and associated signage, as well as trails and one restroom (see Photograph 4). Due to the large area of Chacoan influence that is evidenced at thousands of sites within the Park and outlying areas, it may be said that the entire canyon floor and the surrounding desert areas in CCNHP form a cultural (ethnographic) landscape.

The great house (see Photograph 4) structures are an integral part of the cultural landscape in the Pueblo del Arroyo area. The Pueblo del Arroyo great house structure (29SJ 1947) is located immediately adjacent to the north edge of the Chaco Wash arroyo. The elevation of the ground surface i.e., the canyon floor in the

immediate vicinity of the structure, is approximately 18 feet above the floor of the arroyo.

The great house structures have occupied the canyon floor for approximately 1000 years. Pueblo del Arroyo itself possesses significance within the landscape as an example of Pueblo II to Pueblo III architecture. It is the only excavated and interpreted great house of its size and period with a later attached tri-wall structure in the Chaco core. It forms the primary character-defining feature of the cultural landscape for the erosion control project.

The Pueblo del Arroyo structure was constructed from AD 1075-1150 and consists of over 284 rooms, 16 kivas and an enclosed plaza area. Neil Judd of the National Geographic Society excavated the site between 1923 and 1926 (Canby et al., 1982). The tri-wall structure and associated rooms adjacent to the great house were excavated and stabilized by Gordon Vivian and Leland Abel of the National Park Service in 1950. The structure receives routine and cyclic treatment as part of the Chaco Preservation Program. A Historic Structures Report is being compiled for publication that will include preservation histories, vibration analyses, remote sensing data, and recommendations for backfilling and preservation treatments.

Pueblo del Arroyo is one of the major excavated, interpreted, and stabilized great houses in the Chaco core. The structure's location, while currently precariously close to the wash, must have been necessitated by or been based on some critical association, considering the care in location and orientation that has been documented for other great houses structures. It is apparent that the current wash and arroyo were not present immediately adjacent to the structure when it was built. Possible relationships with regard to the location include direction and or distance from other great houses, roads, or earthen platforms. Little is known regarding the location in the middle of the canyon floor, except that it is fairly unique, most other structures being located along the edges of the canyon.

The vegetation populations present within the park and at the project site (see Section 3.1.3) are also a key component of the cultural landscape. The mostly native vegetation (with the exception of tamarisk in the wash) represent the same species present during Chacoan occupation of the canyon, although distributions may have been different then due to the use patterns of the day. Also, vegetation patterns within the canyon have changed dramatically within the past century. As recently as 50 years ago, there was little to no vegetation on the canyon floor, as documented by historical aerial photos. Since livestock grazing was discontinued within the park around 1950, vegetation in the project area has increased in variety and density, covering what was bare soil.

The Chaco Wash arroyo contributes to the project cultural landscape, especially considering its proximity to Pueblo del Arroyo. The concept of an arroyo cycle that has been developed by researchers during the late 20<sup>th</sup> century (Simons, et al.,

1982) describes arroyos as developing rapidly in response to runoff from extreme, infrequent storm events, and then gradually filling in via sedimentation as less extreme runoff events occur perennially. It is recognized that the canyon floor was incised sometime during the Chacoan occupation. This pre-historic arroyo may have begun filling during the Chacoan period (written communication, Kirk Vincent, USGS, March, 2001) and completely re-filled with sediment sometime between 1300 and 1600 (Love, D., 1983a). This buried arroyo has been traced for several miles along the walls of the present-day arroyo (DeAngelis, J. 1972).

Based on descriptions of Chaco Canyon made by 19<sup>th</sup> century military expeditions followed by 20<sup>th</sup> century scientific studies, it is roughly estimated that the current arroyo began forming in the flat-lying sediments of the canyon floor sometime in the 1860s. A detailed description of Chaco Canyon made in 1852, describing an 1849 expedition through the area makes no mention of an arroyo. The account mentions an intermittent channel and a succession of shallow pools. In 1877, Jackson, of the U.S.G.S Hayden Survey, noted the channel had been abandoned. Jackson reported another 16-foot deep active channel adjacent to Pueblo del Arroyo (Simons et al., 1982).

Thus it appears the present-day arroyo had developed by 1877. Similarly, the cut-off chute developed sometime during the late 19<sup>th</sup> century, possibly in conjunction with the formation of the present arroyo. Previous to this time, the landscape at this location exhibited a flat ground surface extending from the great house structure to the present-day soil island. The arroyo's contribution to the cultural landscape may accordingly be considered a dynamic one, in that its presence in the canyon depends on geomorphological factors that operate over centuries.

### **3.2.3.2 Regulation and Policies**

NPS Management Policies provide that “the treatment of a cultural landscape will preserve significant physical attributes, biotic systems, and uses when those uses contribute to historical significance. Treatment decisions will be based on a cultural landscape's historical significance over time, existing conditions, and use.

Treatment decisions will consider both the natural and built characteristics and features of a landscape, the dynamics inherent in natural processes and continued use, and the concerns of traditionally associated peoples”. Also, contemporary alterations and additions to a cultural landscape must not radically change, obscure, or destroy its significant spatial organization, materials, and features. New construction is allowed if it is necessary to preserve the landscape's integrity and historical character. New construction should be differentiated from existing structures, but in a manner compatible with the historic character of the landscape.

Director's Order 28 (NPS, 1998c) applies preservation standards that stipulate stabilization measures within a cultural landscape detract as little as possible from

the cultural landscape's appearance and significance. Section 106 (NHPA) regulations require evaluation of effects with regard to whether or not the action would adversely effect the property to the extent that its eligibility for National Register (NRHP) listing would be compromised. Actions that alter characteristics that qualify a property for NRHP eligibility are determined to have an *adverse effect* with regard to Section 106 compliance. Damage to all or part of a property constitutes such an alteration (36CFR800.5).

### **3.2.3.3 Historic Structures/Cultural Landscapes Impacts of the No-Action Alternative**

**Impact Analysis:** The No-action alternative would cause indirect long-term adverse effects. Assuming eventual flood-related damage to Pueblo del Arroyo that would partially compromise the integrity of the foundation, most likely on the south side of the structure, adverse effects as evaluated under NEPA criteria would be minor to moderate. It is possible for extensive damage to be incurred by the structure from flood-related erosion. However, impacts are not determined to be major (see Table 3-2) as they would not likely be of sufficient magnitude to cause ineligibility to the NRHP of either the great house structure or the landscape.

Damage to the currently largely intact south side of the structure could constitute a long-term moderate adverse effect to the structure under NEPA criteria, due to the large size and the mostly intact condition of the foundation of the structure. Due to the uniqueness of the Pueblo del Arroyo structure, even partial damage to the Pueblo del Arroyo footprint would alter a character-defining feature of the landscape. The adverse effect on the landscape as viewed from afar, for example from the Pueblo Bonito Overlook, would be minor. However, locally the appearance of the structure as well as access to the damaged areas would undergo a more intense adverse effect. Any damage along the south side of the Pueblo del Arroyo structure would also entail damage to the interpretive trail currently in use along the top of the arroyo in this area. Such damage would also pose a safety hazard for preservation treatment of the damaged areas.

**Cumulative Effects:** Previous erosion control projects in Chaco Wash have had a minor to moderate beneficial effect in stabilizing the floodplain and the arroyo wall at Pueblo del Arroyo. As a result, the cultural landscape has apparently experienced a minor beneficial effect via preservation of one of the great house structures present in it. However, the structure is judged to still be at risk to erosion-related damage from the 100-year flood, especially on the south side of the structure, where flow-retarding large woody vegetation is relatively absent and a cut-off chute lies within 10 feet of the structure. The park implements an ongoing preservation program at Pueblo del Arroyo (masonry repair and preservation), also constituting a minor beneficial effect. The adverse effects associated with the no-

action alternative (potential damage to Pueblo del Arroyo and the cultural landscape) in conjunction with previous erosion control activities would constitute a cumulative adverse effect.

**Conclusion:** The no-action alternative would have an indirect long-term moderate adverse effect on the Historic Structure and also the Cultural Landscape, under NEPA criteria. Considerations of the uniqueness and the NRHP-eligibility of the structure lead to the determination that any damage would alter a character-defining feature of the cultural landscape. Cumulative effects of previous erosion control actions in conjunction with the indirect effects of the No-Action Alternative would be adverse, and moderate in intensity.

**-Section 106 Determination:** Any damage to the Pueblo del Arroyo structure would meet the criteria of adverse effect as specified under the Advisory Council on Historic Preservation regulations. Accordingly, the No-Action Alternative would result in an *adverse effect* under Section 106 criteria.

#### **3.2.3.4 Historic Structures/Cultural Landscapes Effects of the Preferred Alternative**

**Impact Analysis:** The preferred alternative would have a direct minor beneficial effect by virtue of preserving character-defining features of Pueblo del Arroyo historic structure and the surrounding cultural landscape. Considered strictly, since the arroyo and especially the cut-off chute are recent features, placement of fill would not adversely affect the cultural landscape to the degree that character-defining features would be altered. Viewed closely, e.g., from the interpretive trail along the south side of Pueblo del Arroyo, the cable-rail fence would be partially visible along the base of the arroyo wall. Mitigation to reduce the fencing visibility would consist of the incorporation of brush bundles and dead branches into the fence, to break up the linear appearance of the steel cables. Fast growing native vegetation such as rabbitbrush would be encouraged to grow around and through the fence. The establishment of flow-retarding woody vegetation along the floodplain in front of the structure would encourage sedimentation along this area, thereby stabilizing the arroyo wall while not adversely affecting the cultural landscape.

**Cumulative Effects:** Previous erosion control actions within the Wash have had a minor beneficial effect by protecting the structure and the cultural landscape from erosion-related damage. The park implements an ongoing preservation program at Pueblo del Arroyo (masonry repair and preservation), also constituting a minor beneficial effect. The further stabilization of the arroyo wall through fill placement, installation of cable-rail fencing, and renewed establishment of flow-retarding vegetation on the floodplain floor will greatly increase this beneficial effect with regard to preservation of the Historic Structure. The cumulative effect of the



Preferred Alternative in conjunction with past, current and reasonably foreseeable actions would be to preserve and extend a minor beneficial effect.

**Conclusion:** The Preferred Alternative would constitute a minor long-term beneficial effect by ensuring long-term preservation of Pueblo del Arroyo. The cable-rail fence stabilization feature along the base of the arroyo wall would be an artificial addition to the historic scene, partially visible from the south side of Pueblo del Arroyo. Mitigation would lessen the visual impact of this single linear feature. This feature would not affect character-defining patterns of the structure, or those of the cultural landscape. The surrounding National Register (NRHP) eligible properties will not be adversely affected by the erosion control efforts. The cumulative effect of the Preferred Alternative in conjunction with past, current and reasonably foreseeable actions would be to preserve and extend a minor beneficial effect. Considering the beneficial effect, there would be no impairment of cultural landscape or historic structures resources.

**-Section 106 Determination:** Long-term beneficial effects would be the result of implementation of the preferred alternative. A unique Historic Structure and Cultural Landscape would be preserved for future generations. Due to the minimal impact to this resource, the Preferred Alternative would not detract from the site's character-defining features, nor result in a change in use of either the Historic Structure or the Cultural Landscape. The preferred alternative would have *no adverse effect* on the site under Section 106 criteria.

### **3.2.3.5 Historic Structures/Cultural Landscapes Impacts of Alternative 3**

**Impact Analysis:** Alternative 3, installation of jetty fields, would cause a minor indirect beneficial effect by reducing risk of erosion-related damage to the great house, thereby preserving the Pueblo del Arroyo structure and by extension the historic landscape. The degree of preservation would not be as definitive as for the Preferred Alternative, since the cut-off chute would remain open to flows although the velocity would be reduced relative to that for current flood-stage conditions. While the jetties would reduce flow velocities adjacent to Pueblo del Arroyo and in the cutoff chute, extensive erosion could occur during a severe flood event like that associated with a 100-year storm, especially if sedimentation had not built up the arroyo wall appreciably. Such erosion may be expected to lead to damage to the great house structure.

Considered strictly, since the arroyo is a recent, apparently temporary, cyclic landscape feature, the jetties would not adversely effect the cultural landscape to the degree that character-defining features would be altered. The rows of steel fencing extending out into the arroyo from the arroyo wall would be highly visible and fairly obtrusive. Since the jetties would detract from the historic feeling of the

site, they would constitute a negligible-to-minor adverse effect upon the cultural landscape.

The jetty field would be visible from various locations along Pueblo Alto Trail overlook vantage points, but would be highly visible from the south side of the great house interpretive trail and from the south side of the arroyo. Mitigation to reduce the adverse effect on the historical scene and feeling of the site would include softening the lines of the steel cable-rail fences by weaving brush bundles and other debris from the arroyo floor through the fencing, and by encouraging vegetation that would at least partly obscure the fencing within a few years.

**Cumulative Effects:** Previous erosion control actions within the Wash have had a minor beneficial effect with regard to protecting the structure from erosion-related damage. The flow velocity reduction along the arroyo wall and accompanying sedimentation afforded by the jetty fields would enhance this beneficial effect with regard to preservation of the Historic Structure. The park implements an ongoing preservation program at Pueblo del Arroyo (masonry repair and preservation), also constituting a minor beneficial effect.

The cumulative effect of Alternative 3 in conjunction with the effects of past, current, and reasonably foreseeable actions would constitute a minor beneficial, although not to the degree associated with the Preferred Alternative. The erosion protection afforded to the great house by Alternative 3 would extend preservation through a more long-term timeframe.

**Conclusion:** Alternative 3 would have an indirect minor beneficial effect upon the historic structure and cultural landscape, since the risk of erosion-related damage would be reduced. However, the degree of preservation would not be as definitive as for the Preferred Alternative, and Alternative 3 would also pose a minor adverse effect on the local cultural landscape due to the detraction from the historic feeling of the site from the presence of the jetty fields. These two aspects would tend to cancel each other for a period of time (several years) until the jetty field became less obtrusive to the historic feeling. Eventually the beneficial effects (protection from erosion) would dominate as the adverse effect (detraction from the historic scene) lessened as the jetties became buried with sediment. The cumulative effect of Alternative 3 in conjunction with the effects of past, current, and reasonably foreseeable actions with regard to preservation of the cultural landscape would be beneficial, although of lower degree than the cumulative effect to be expected from the Preferred Alternative.

**-Section 106 Determination:** The cultural landscape would be preserved, but the materials and feeling of the overall Pueblo del Arroyo site complex would be temporarily diminished. Because the alteration caused by Alternative 3 to the historic feeling (and thereby the cultural landscape) of the site would be minor, the determination of effect for Section 106 compliance would be *no adverse effect*.

### 3.2.4 Ethnographic Resources

#### 3.2.4.1 Affected Environment

Pueblo del Arroyo meets the definition of a traditional cultural property (TCP), a specific type of ethnographic resource. Ethnographic resources are defined by the National Park Service as any “site, structure, object, landscape, or natural resource feature assigned traditional legendary, religious, subsistence, or other significance in the cultural system of a group traditionally associated with it” (Director’s Order # 28, *Cultural Resources Management*). Traditional cultural significance is derived from the role a property plays in a community’s historically rooted beliefs, customs, and practices. All of Chaco Culture NHP, including Pueblo del Arroyo, meets the NHRP definition of a traditional cultural property because it is a location associated with the traditional beliefs of several Native American groups regarding their origins and cultural history (Parker and King, 1998; NRHP Bulletin 38, *Guidelines for Evaluating and Documenting Traditional Cultural Properties*).

The Park maintains an active consultation program with Native American Pueblos and Nations. Numerous Native American Tribal organizations have cultural ties to the prehistoric Ancestral Puebloan culture, whose members lived in Chaco Canyon and throughout the Four Corners region during the period of Chacoan occupation of the canyon. Contemporary Native Americans with ties to the Ancestral Puebloan culture live throughout Arizona and New Mexico. Chaco Culture NHP does not presently have a formal Ethnographic Resource Inventory.

Native American tribal representatives have expressed a variety of positions with regard to construction activities at the site. An onsite consultation meeting was held on July 17, 2001 to continue scoping for the erosion control at Pueblo del Arroyo. The project was further discussed with tribal representatives in June 2002, at a meeting at the San Juan County Administrative Building in Aztec, New Mexico. Nine tribes were present: Navajo Zia, Hopi, Cochiti, Ysleta Del Sur, Isleta, Nambe, Santa Ana, and Acoma. Additional discussion regarding the erosion control project occurred in the fall of 2002 during general agreement talks with three tribes (personal communication, CCNHP Cultural Resources Dept., February 2004). The project was again discussed at a meeting on July 17, 2004 meeting in Grants, New Mexico. The meetings were for park management issues relating to both Aztec Ruins National Monument and Chaco Culture NHP. The identified alternatives were discussed and dialogue has been documented.

No objections to the overall goal of protecting the site from severe erosion, on the basis of traditional use of the site, have been forwarded to CCNHP by the Pueblos and Indian Nations with whom consultation has been initiated. A variety of viewpoints and attitudes regarding protection of Pueblo del Arroyo from flood-

related damage have been expressed. These views range from the idea that erosion is a natural process and should be allowed to proceed, i.e., all things return to the earth from whence they were made, to the view that Pueblo del Arroyo and other great house site should be preserved to protect the interests and accomplishment of the ancestors by allowing large numbers of people to experience the sites. Some comments advised for the use of a revetment to protect the site.

#### **3.2.4.2 Regulation and Policies**

Section 101(d)(6)(B) of NHPA requires consultation with Indian tribes that attach religious and cultural significance to historic properties. The Federal agency must make a reasonable and good faith effort to identify such Indian tribes and invite them to be consulting parties. Executive Order 13007 requires the NPS to accommodate ceremonial use of Indian Sacred Sites and to avoid adversely affecting the physical integrity of such sites.

In light of disparate views put forward by tribal representatives regarding protection of the Pueblo del Arroyo site from flooding, NPS policy is used to guide decisions on this topic. NPS Director's Order 28 (1998c) advocates preserving the integrity of ethnographic resources to maintain the cultural heritage of associated groups. Impacts to ethnographic resources are evaluated in terms of their adverse effect on the integrity of the traditional cultural site. Inasmuch as modern construction at Pueblo del Arroyo is minimal, adverse impacts to cultural integrity are measured by the degree of introduction of modern materials and structures to the ethnographic landscape. The assessments of effect accordingly closely match those for the topic of cultural landscapes, described above. Impacts to the cultural landscape are also impacts to the ethnographic value of the traditional cultural site.

#### **3.2.4.3 Ethnographic Resources Impacts of the No-Action Alternative**

**Impact Analysis:** There would be minor to moderate indirect adverse effects upon the traditional cultural resource posed by the No-action Alternative. These effects would be associated with a future flood event that causes serious damage to Pueblo del Arroyo. Due to the uniqueness of the Pueblo del Arroyo structure, even partial damage to the Pueblo del Arroyo footprint would alter a character-defining feature of the traditional cultural site. There would be no direct adverse effects.

**Cumulative Effects:** Previous erosion control projects in Chaco Wash have resulted in a degree of stabilization of the floodplain and the arroyo wall at Pueblo del Arroyo, thereby preserving the traditional cultural resource. The arroyo wall is judged to still be at risk to erosion from flooding, especially on the south side of the structure, where the cut-off chute is located within 10 feet of the structure. The indirect adverse effects associated with the no-action alternative in conjunction

with past, current and reasonably foreseeable action would result in a cumulative adverse effect with regard to protection of Pueblo del Arroyo from erosion, and an associated adverse cumulative effect upon the traditional cultural resource.

**Conclusion:** The no-action alternative would have an indirect minor to moderate adverse effect on the traditional cultural resource, under NEPA criteria.

Considerations of the uniqueness and the NRHP-eligibility of the site and the uncertainty involving the magnitude of damage that could occur, lead to the determination that any damage would alter a character-defining feature of the traditional cultural property. Cumulative effects of the No-Action Alternative in conjunction with the effects of past, current and future actions would be adverse, and of minor to moderate intensity.

**-Section 106 Determination:** Application of the criteria of adverse effect as specified under the Advisory Council on Historic Preservation regulations, including effects such as those defined at

- 36 CFR 800.5(a)2(i): "Physical destruction of or damage to all or part of the property" and
- 36 CFR 800.5(a)2(iv): "Change of the character of the property's use..."

lead to the determination that the No-Action Alternative would result in an *adverse effect* on the traditional cultural site under Section 106 criteria.

#### **3.2.4.4 Ethnographic Resources Impacts of the Preferred Alternative**

**Impact Analysis:** The preferred alternative would have a direct minor beneficial effect upon the traditional cultural resource (Pueblo del Arroyo). The reduction of risk of erosion-related damage to the site through fencing and fill placement, thereby preserving the traditional cultural resource, would constitute a long-term beneficial effect.

**Cumulative Effects:** Previous erosion control actions within the Wash have had a minor beneficial effect with regard to protecting the structure from erosion-related damage. The park implements an ongoing preservation program at Pueblo del Arroyo (masonry repair and preservation), also constituting a minor beneficial effect. The effect of the preferred alternative would be to preserve the Pueblo del Arroyo structure by protecting it from erosion caused damage, thus preserving the traditional cultural property as much as possible. The cumulative effect of the Preferred Alternative in conjunction with past, current and reasonably foreseeable future actions would be a long term beneficial effect.

**Conclusion:** The Preferred Alternative would constitute a direct long-term minor beneficial effect on the traditional cultural resource. Ultimately the preferred alternative may be expected to provide a high level of stabilization that would

prevent erosion during major flooding, constituting a minor beneficial effect with regard to preservation of the Pueblo del Arroyo traditional cultural site. The cumulative effect of the Preferred Alternative in conjunction with past, current and reasonably foreseeable future actions would be a long term beneficial effect. Considering the beneficial effects, there would be no impairment of ethnographic resources.

**-Section 106 Determination:** Long-term beneficial effects would be the result of implementation of the preferred alternative. The integrity of a unique traditional cultural resource would be preserved for future generations. The preferred alternative would have *no adverse effect* on the ethnographic value or use of the site under Section 106 criteria.

#### 3.2.4.5 Ethnographic Resources Impacts of Alternative 3

**Impact Analysis:** Alternative 3 would cause an indirect long-term minor beneficial effect upon the traditional cultural resource, although to a lesser degree than the Preferred Alternative. The beneficial effect would be indirect, a result of the reduction of flood-related damage to Pueblo del Arroyo. The beneficial effect would be of lesser degree than that associated with the Preferred Alternative because the cut-off chute would remain open, resulting in a lower reduction of risk of flood-related damage. The obtrusiveness of the jetty fields would also constitute a negligible to minor direct adverse effect.

**Cumulative Effects:** Previous erosion control efforts have had a minor beneficial effect on the Pueblo del Arroyo traditional cultural resource by reducing the risk of damage. . The park implements an ongoing preservation program at Pueblo del Arroyo (masonry repair and preservation), also constituting a minor beneficial effect. The cumulative effect upon ethnographic resources of Alternative 3 in conjunction with past, current and future actions would be a minor beneficial effect, dominated by the effects of Alternative 3.

**Conclusion:** Alternative 3 would have a minor beneficial effect on ethnographic resources at Pueblo del Arroyo, through preservation of the traditional cultural resource. The beneficial effect would be of a lesser degree than that for the Preferred Alternative, due to the lower reduction of risk of damage. Cumulative effects of Alternative 3 in conjunction with past, current and future actions would be beneficial, and minor in intensity. However, the jetty fields would present a somewhat obtrusive set of structures adjacent to the traditional cultural resource, somewhat detracting from the traditional setting.

**-Section 106 Determination:** Since no character-defining features of the traditional cultural resource would be caused by Alternative 3, the determination of effect for Section 106 compliance would be *no adverse effect*.

### **3.3 Visitor Experience, Understanding, And Appreciation**

The visitor use topic of Visitor Experience, including visitor understanding and appreciation, was analyzed with regard to effects of the alternatives considered. Approximately 42,000 people visit the Park each year, with 35,000 of these during the summer months (May-September).

#### **3.3.1 Affected Environment**

The affected environment for the topic of Visitor Experience consists of the canyon floor and related areas accessible from the Visitor Loop Road; the road comprises an-eight-mile round trip. This area is located at the west end of the Visitor Loop road, and represents the westernmost extent of visitor vehicular travel within the Park. The Pueblo del Arroyo interpretive trail begins at the parking lot located just north of the site (Figure 1-2). The self-guided interpretive trail extends around the perimeter as well as through interior portions of the structure, allowing full inspection of the multiple-room character of the great house. Occasionally, ranger-guided interpretive tours are conducted at the site. The Pueblo del Arroyo parking lot area is typically used by hikers who continue further west along the canyon floor towards Penasco Blanco, or access the Pueblo Alto Trail near Kin Kletso.

The natural desert soundscape in the park has been preserved to as great a degree as possible by NPS. Natural sounds at the site include bird calls (generally during the summer months), the sound of flowing water during infrequent large streamflows, the wind itself and the wind through vegetation and over soils. Artificial contributions to the natural soundscape include aircraft overflights, motor vehicle travel on the Visitor Loop Road and typical visitor conversation.

The canyon floor in the Pueblo del Arroyo/Pueblo Bonito area forms a panorama visible from the Pueblo Alto Trailhead. The trail extends along a cliff at the top of the lowermost bench of the north wall of Chaco Canyon, approximately 90 feet above the canyon floor.

#### **3.3.2 Methodology**

Impacts on the ability of visitors to experience a full range of park resources were analyzed within the context of the sites within the Park that a majority of visitors use and appreciate. These are the large Chacoan architectural structures on the canyon floor that can be experienced while driving the eight-mile round-trip Visitor Loop Road. Also considered in arriving at determinations of effect on

visitor use are the significance and uniqueness of the Pueblo del Arroyo site, in conjunction with the degree to which it is currently accessible to the public. Table 3-3 summarizes the definitions used in evaluating adverse effects to visitor experience.

**Table 3-3  
Visitor Experience Effect Definitions**

<b>Visitor Use Category</b>	<b>Negligible</b>	<b>Minor</b>	<b>Moderate</b>	<b>Major</b>
Visitor Experience Short- term - occurs only during the treatment action Long- term - occurs after the treatment action	Little noticeable change in visitor experience, and/or will affect few visitors.	Changes desired experiences but without appreciably limiting or enhancing critical characteristics of the experience, and/or will affect some visitors.	Changes critical characteristics of the desired experience or reduces or increases the number of participants, and/or will affect many visitors.	Eliminates, detracts from or greatly enhances multiple critical characteristics of the desired experience or greatly reduces or increases participation, and/or will affect the majority of visitors.

*Table adapted from NPS, 2003. Sample Impact Threshold Definitions And Methodology Sections. National Park Service U.S. Department of the Interior, Intermountain Support Office, Denver. August 14, 2003.*

### **3.3.3 Regulation and Policies**

The Organic Act requires that Park activities not result in impairment of Park values or resources, including scenery and natural and historic objects, and any specific attributes encompassed by the specific values and purposes for which the Park was established. Also prohibited are impairments of opportunities to experience enjoyment of these resources.

Director's Order 47, *Soundscape Preservation and Noise Management*, requires of the Park Service that where natural soundscape conditions are currently not impacted by inappropriate noise sources, the objective must be to maintain those conditions. Where the soundscape is found to be degraded, the objective is to facilitate and promote progress toward the restoration of the natural soundscape. Exceptions to this basic principle are permitted in the case of activities that are appropriate to the park under the NPS Organic Act and other relevant legislation related to natural and cultural resource management or the provision of visitor services, including appropriate management and maintenance activities. In these situations, soundscape management goals are to reduce noise to minimum levels consistent with the appropriate service or activity, as long as that service or activity continues to be needed.



NPS Management Policies require the prevention or minimization of all noise that, through frequency, magnitude, or duration, adversely affects the natural soundscape or other park resources or values.

### 3.3.4 Visitor Experience Impacts of the No-Action Alternative

**Impact Analysis:** Direct effects of the No-action alternative would be negligible, as the current visitor experience would not be affected. Indirect effects would be adverse, due to the risk of erosion-related damage to Pueblo del Arroyo at some time in the future. Erosion along the south side of the structure would likely necessitate permanent closure of a minimum of 100 feet of interpretive trail along this side of the structure. Within the context of the entire Park the adverse effect would be minor, but due to the long-term nature of such damage to the great house structure, the adverse effect is determined to be minor to moderate. This is because the majority of visitors for the foreseeable future would experience a diminished use and appreciation of the Pueblo del Arroyo structure. Damage to the structure along the south side would necessitate closure of approximately 120 feet of interpretive trail. This diminished use would be partially mitigated through interpretive displays or signage, explaining the natural arroyo cycle of erosion and aggradational processes. Studies performed by the USGS documenting this cycle and flow dynamics within the arroyo through time would be summarized.

**Cumulative Effects:** Previous erosion control and preservation activities have had a net moderate beneficial effect upon visitor experience, through preservation of the Pueblo del Arroyo great house structure. The No-Action Alternative would pose an indirect adverse effect, which in conjunction with the beneficial effects of previous, current and future actions would result in a cumulative minor adverse effect upon visitor experience.

**Conclusion:** The no-action alternative would cause a *minor adverse effect* upon visitor use and experience, due to eventual erosion-related damage to Pueblo del Arroyo and accompanying reduction in use at the site. Cumulative effects of previous erosion control measures and current and future preservation measures in conjunction with the effects of the No-Action Alternative would result in a minor adverse effect on visitor experience, due to a reduction in use.

### 3.3.5 Visitor Experience Impacts of the Preferred Alternative

**Impact Analysis:** Long-term minor beneficial effects upon visitor use would be the result of the Preferred Alternative, due to preservation of the Great house structure. Short-term adverse effects would be negligible to minor, as a result of temporary closure of the interpretive trail along the south side of Pueblo del Arroyo

(150 to 200 feet of trail closure) for approximately two months during implementation of the Preferred Alternative. Also, during construction the use of machinery (bob-cats, loaders, conveyors) for fill placement and the presence of dump trucks on the visitor loop road for several weeks would contribute significantly to short term noise impacts in the canyon. Minimization of these adverse effects would be achieved by performing the construction during the winter, when visitor use of the Park is typically lowest, generally less than 10 percent of annual visitation. Another adverse effect would be posed by the presence of bare ground disturbed during implementation of the preferred alternative. Re-vegetation of these areas with native plants would take from two to five years. This long-term effect on visitor experience is determined to be negligible, since it would not limit critical components of the experience, would be temporary, and would be limited to a local area at Pueblo del Arroyo.

Users of the Pueblo Alto Trail in the vicinity of the project would experience a minor short-term degradation of the scenic and/or aesthetic value of the canyon floor in the area of Pueblo del Arroyo. The presence of construction machinery in the arroyo adjacent to the great house structure would constitute a dissonant element in the peaceful landscape. These effects would be temporary.

**Cumulative Effects:** Previous erosion control actions within Chaco Wash are likely to have posed a small distraction to visitors enjoying the Park. Other construction activities within the Park, most notably the construction of the Visitor Loop Road, have likely had a similar short-term effect on visitor experience. Future planned vegetation management within the arroyo will likely result in similar long-term, temporary localized disturbances. In the context of the timeframe during which the Park has been in existence, the intensity of such adverse effects has been negligible. Overall these actions have had a long-term beneficial effect on visitor experience. The short-term adverse and long-term beneficial effects of the preferred alternative, when combined with the effects of past, present, and foreseeable future resource management actions, result in an overall *minor beneficial* cumulative impact on Visitor Experience.

**Conclusion:** Since the direct adverse effects of the project would only be experienced in a localized area during the low-use part of the year (winter), the short-term effects would be negligible. The temporary closure of an interpretive trail along the south side of the structure would represent only a minor adverse effect upon visitor experience, due to the continued opportunities to experience many other prehistoric structures located along the visitor loop road and via hiking trails elsewhere throughout the park. In the long-term, Visitor Experience would undergo a minor beneficial effect due to preservation of the Pueblo del Arroyo structure for appreciation of future generations. Cumulative effects would be beneficial, long-term, and minor in intensity. Considering the beneficial effects, there would be no impairment of Visitor Experience.

### 3.3.6 Visitor Use Impacts of Alternative 3

**Impact Analysis:** Effects from Alternative 3 on visitor experience would be a combination of direct, minor, long-term adverse effects through the addition of dissonant elements to the cultural scene and indirect, minor, long-term, beneficial effects through preservation of the site for continued use by visitors. The beneficial preservation effect would be indirect since risk of erosion would be reduced, but damage could still occur at the cut-off chute.

The industrial appearance of the steel jacks and cables of a jetty field immediately adjacent to the Pueblo del Arroyo great house site may pose a localized minor adverse long-term effect upon appreciation, due to the aesthetic degradation of the natural scene. Such an adverse effect would be experienced by all future visitors until the jetty fields were buried by continued aggradation; however, its localized nature within the context of the park as a whole results in a *negligible-to-minor* intensity.

Short-term adverse effects would be negligible, since Pueblo del Arroyo is only one of several great house sites open to visitors. Only the trail along the south side of the structure would be temporarily closed. Visitor distraction due to noise and commotion would be minimal, since the materials that would be placed in the arroyo are of relatively small volume, and could be mobilized with smaller machinery, such as a backhoe/loader.

**Cumulative Effects:** Cumulative effects would be similar to those for the preferred alternative. The cumulative short-term adverse and long-term beneficial effects of the preferred alternative on Visitor Experience, when combined such impacts from other past, present, and foreseeable future resource management actions, result in an overall *minor beneficial* cumulative impact.

**Conclusion:** Long-term effects would be indirect and beneficial due to preservation of the Pueblo del Arroyo structure for appreciation of future generations. Since the direct adverse effects of the project would only be experienced in a localized area during the low-use part of the year (winter), the short-term effects would be negligible. Cumulative effects would be beneficial, long-term, and minor in intensity. Considering the beneficial effects, there would be no impairment of Visitor Experience.

## 4.0 Consultation/Coordination

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## Glossary

Ancestral Puebloan Culture- Societies or groups of people who lived throughout the Four Corners region during the pre-historic era, who utilized architectural stone structures for their living accommodations. Sometimes also referred to as the “Anasazi” people or culture. Several modern Native American nations and/or Pueblos maintain traditional ties to the ancestral Puebloan culture.

Arroyo wall – The lateral limits of the arroyos within CCNHP. The arroyo walls are typically vertical, a function of the fine-grained soil that composes the walls, although some portions are sloped, usually due to man-made alterations to the landscape. The term “arroyo bank” is incorrect. The inner channel, which conveys most flows through the arroyo floodplain, does possess banks, as in the term “channel bank”.

Alluvial aquifer – The shallow aquifer that exists in the unconsolidated sediments underlying Chaco Canyon. Groundwater exists in these sediments that were deposited by flowing water (alluvium).

Cable-Rail Fence – A type of intermittent erosion control structure constructed of heavy steel posts (railroad rails have been used in the past; also, heavy gauge angle steel works equally well) and steel cable. The steel rails are used to construct tetrahedral-shaped stanchions between which steel cables are stretched, forming a durable, long-lasting fence. Three 10-foot long rails are used for each stanchion. The three rails are set at a 70-degree angle with four feet underground and six feet extending above the surface; the rails meet five feet aboveground. The tetrahedral stanchions are placed fairly close together, such that the distance from the apex of one tetrahedron to the next one adjacent is five to six feet. Heavy steel cables are strung from apex to apex, fastened to each with cable clamps. Wire mesh (6-inch openings) is affixed to the lower portions of the stanchions to provide additional roughness (the cabling and mesh retain floating debris, further reducing flow velocity). When installed parallel to the bank of a channel the fence acts as a permeable revetment, inducing aggradation along its length. When such a fence extends into the flow path, it acts as a *jetty*.

Chaco core – The area within CCNHP generally located within Chaco Canyon, and comprising the great houses and associated cultural sites. The Chaco core is contrasted with the numerous outlying cultural sites that exist elsewhere within the park proper as well as at several isolated outlying locations within the Four Corners region.

Critical Reach – The section of Chaco Wash that extends from the Pueblo Bonito Bridge downstream to Kin Kletso, a distance of approximately one mile as measured along the streamcourse.

Cumulative effects - "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions" (CEQ Regulations, 40 CFR 1508.7).

Drop Structure – A solid structure installed across a channel to prevent down-cutting (grade control) of unconsolidated substrate. The drop structure utilizes a solid apron on the downstream side to deflect the energy of the water as it drops. Use of drop structures in the Chaco Wash watershed has been unsuccessful, due to undermining of the structures during heavy flooding. Also called check dams when used on a smaller scale.

Fill material – Within the context of wetlands and water bodies, fill is material used for the purpose of replacing aquatic land with dry land or changing the bottom elevation of any water body. From a construction standpoint, fill is material used to alter the topography of a piece of land. In this Environmental Assessment, the term is used more in the construction sense, since the areas of fill application are typically above water.

Gabion – A rock-filled basket used for anchoring or stabilizing a structure. Commercially available wire baskets are used for soil slope protection. The square baskets are constructed on-site, filled with rock cobbles, and a top wired in place. Successive baskets are wired together during construction, forming a permeable, somewhat flexible structure over the slope.

Great house – a modern name given to any of the several monumental pre-historic structures built during the Chacoan occupation

Hydraulic Adjustment – The response of channel flow to changes in channel morphology. Such changes may include increases in floodplain vegetation, introduction of jetties, buildup of debris, shortening or lengthening of the channel, and aggradation or erosion of grade level. Flow responses mainly include localized flow velocity changes.

Interpretation – Dissemination to the public in a educational summary format of key concepts and histories of park resources and values.

Jetty – A permeable structure (such as a cable-rail fence or a row of pilings) oriented perpendicular or sub-perpendicular (to about 70 degrees) to the direction of flow; used to guide flows by reducing velocity.

Jetty field – A series of jetties used to protect a large area from erosion. As used in this report, a jetty field would consist of 10- to 40-foot long (depending on floodplain width present) cable-and rail fences extending out from the arroyo wall, oriented approximately 70 degrees to the downstream arroyo wall. The

fences would be spaced 20-25 feet apart. Jetty fields also control erosion indirectly by causing aggradation.

Local viewshed – The portion of the Park visible from a given point location, such as at Pueblo del Arroyo, or from a point along the Pueblo Alto Trail, overlooking the Canyon core complex. The viewshed includes all elements of the landscape visible to visitors from a particular location.

Mitigation – A type of action taken to alleviate adverse effects engendered upon other resources by the primary activity.

Ordinary high-water mark – This is a series of elevations coinciding with the top edges of the inner channel within the arroyo. The inner channel conveys most flows in the wash, except for those associated with flooding, where the flow volume exceed the carrying capacity of the inner channel.

Revetment – An erosion control structure that directly protects against erosion by armoring or bulwarking a slope. Revetments may be permeable or solid, but provide a continuous surface that prevents erosion. Typical building materials include concrete, gabion, and soil cement.

Sedimentation – The process whereby flowing water deposits transported fine-grained natural material (sand, silt, clay), building up or aggrading the landscape.

Surface water environment – The alluvial or lacustrine environment, comprising flowing washes, streams, ponds, and lakes and biota that live within them.



Photograph taken from the south side of Chaco Arroyo, looking north. The inner channel is incised into the arroyo floodplain in the foreground, and traced by the dashed line. It extends through the foreground, from the rabbitbrush (yellowish plant at extreme right) to just below the cottonwood tree (at extreme left). The soil "island" is just left of the cable-and-rail fence, which is located across the upstream end of the chute. *Photo Credit: Tom Ricketts*

**PUEBLO del ARROYO – SOUTH SIDE VIEW**

**PUEBLO del ARROYO EROSION CONTROL PROJECT  
ENVIRONMENTAL ASSESSMENT  
Chaco Culture National Historical Park, New Mexico**

**PHOTOGRAPH 1**







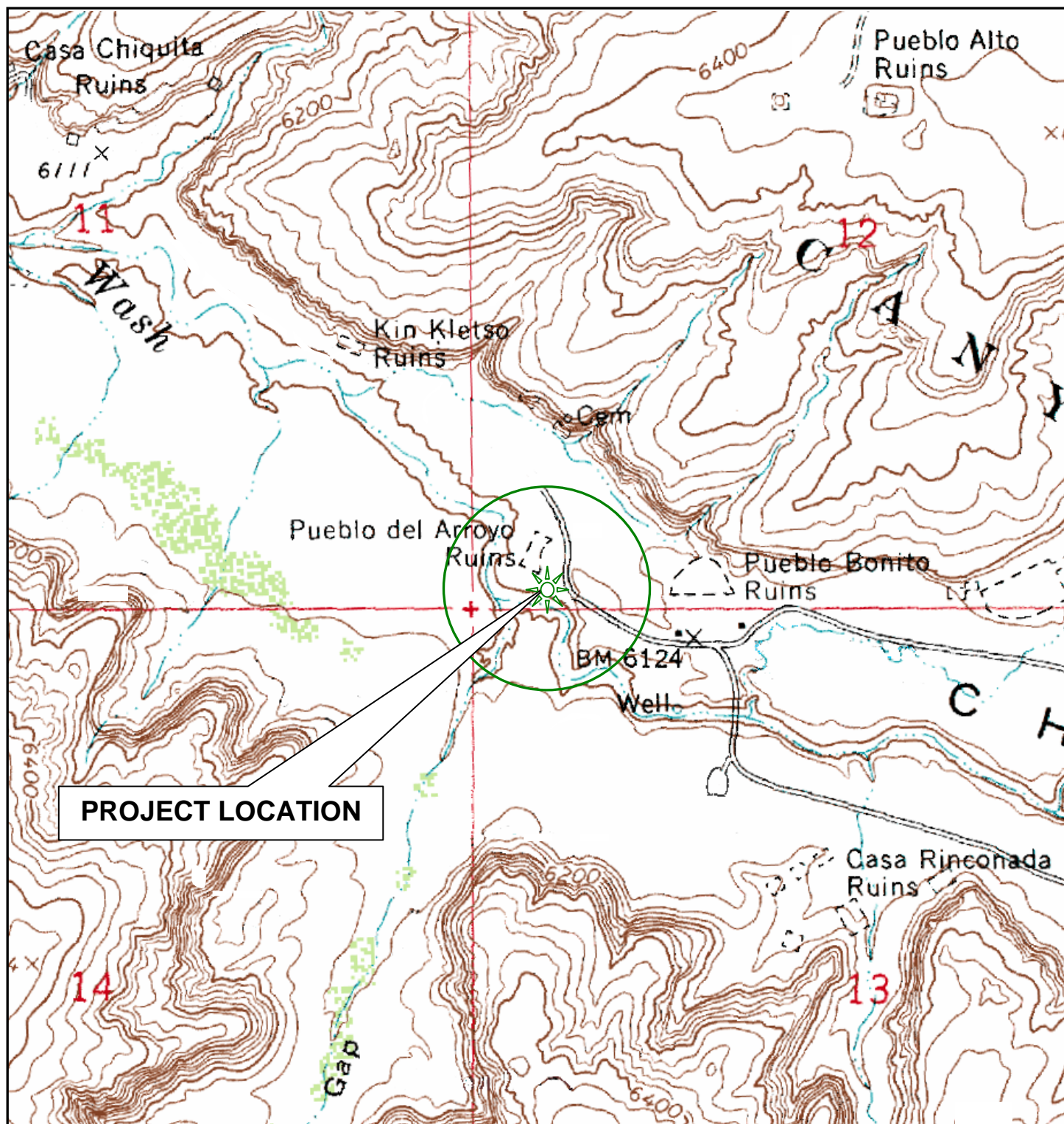
This photograph shows the cut-off chute and soil island at Pueblo del Arroyo. The photograph was taken from the southeast corner of the great house, looking due west.

**CHUTE at SOUTHWEST CORNER of PUEBLO del ARROYO**

**PUEBLO del ARROYO EROSION CONTROL PROJECT  
ENVIRONMENTAL ASSESSMENT  
Chaco Culture National Historical Park, New Mexico**

**PHOTOGRAPH 2**

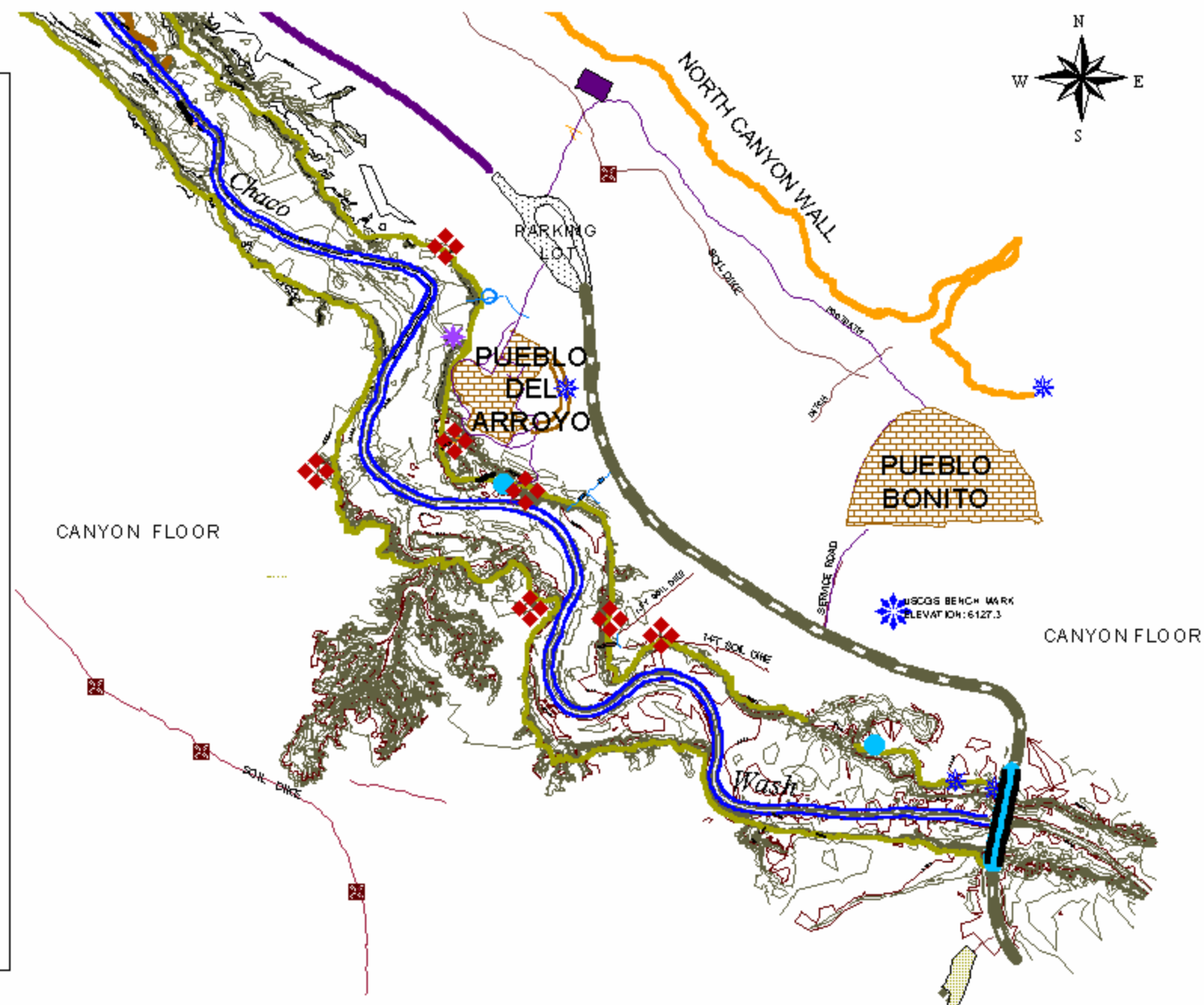
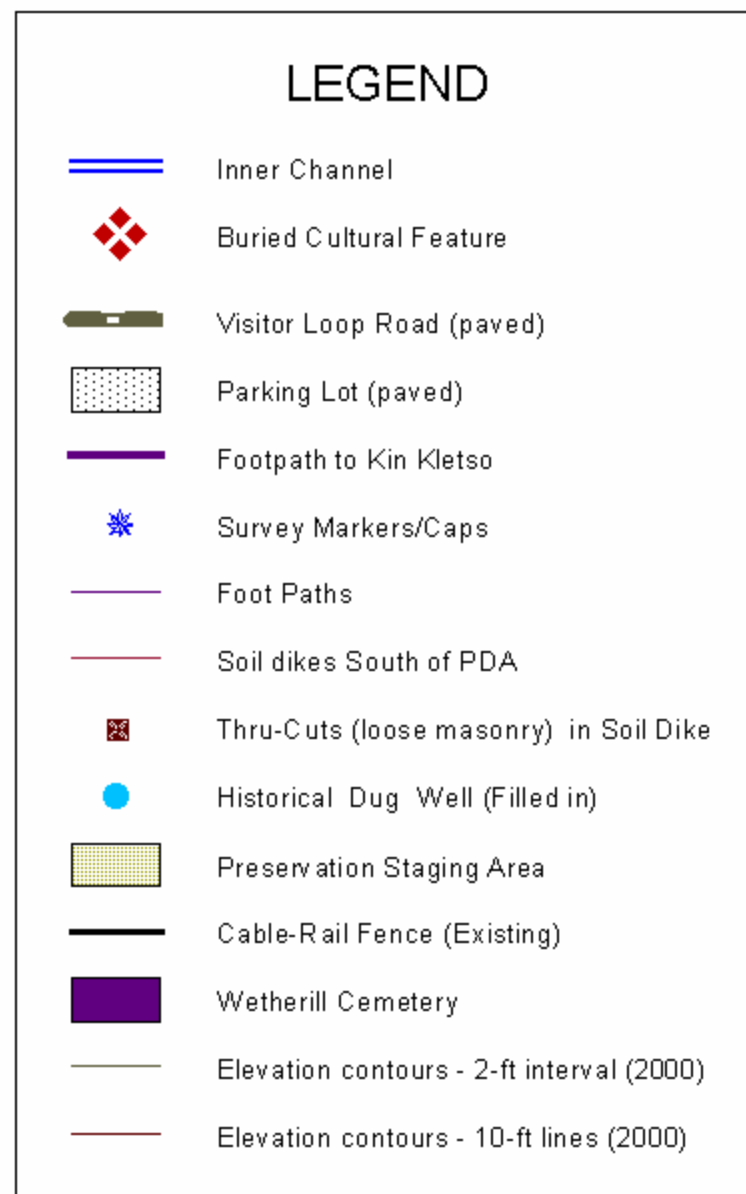




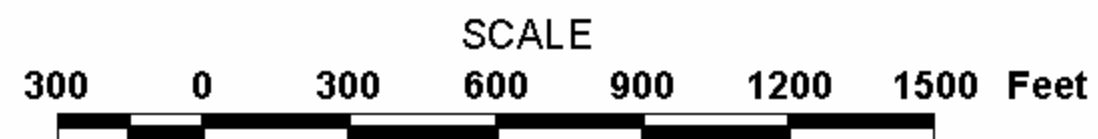
# TOPOGRAPHIC MAP OF SITE AREA

**PUEBLO del ARROYO EROSION CONTROL PROJECT  
 ENVIRONMENTAL ASSESSMENT  
 Chaco Culture National Historical Park, New Mexico**

**FIGURE 1-1**



Note: Chaco Wash flow direction is from southeast to northwest.



U.S. Department of the Interior  
National Park Service

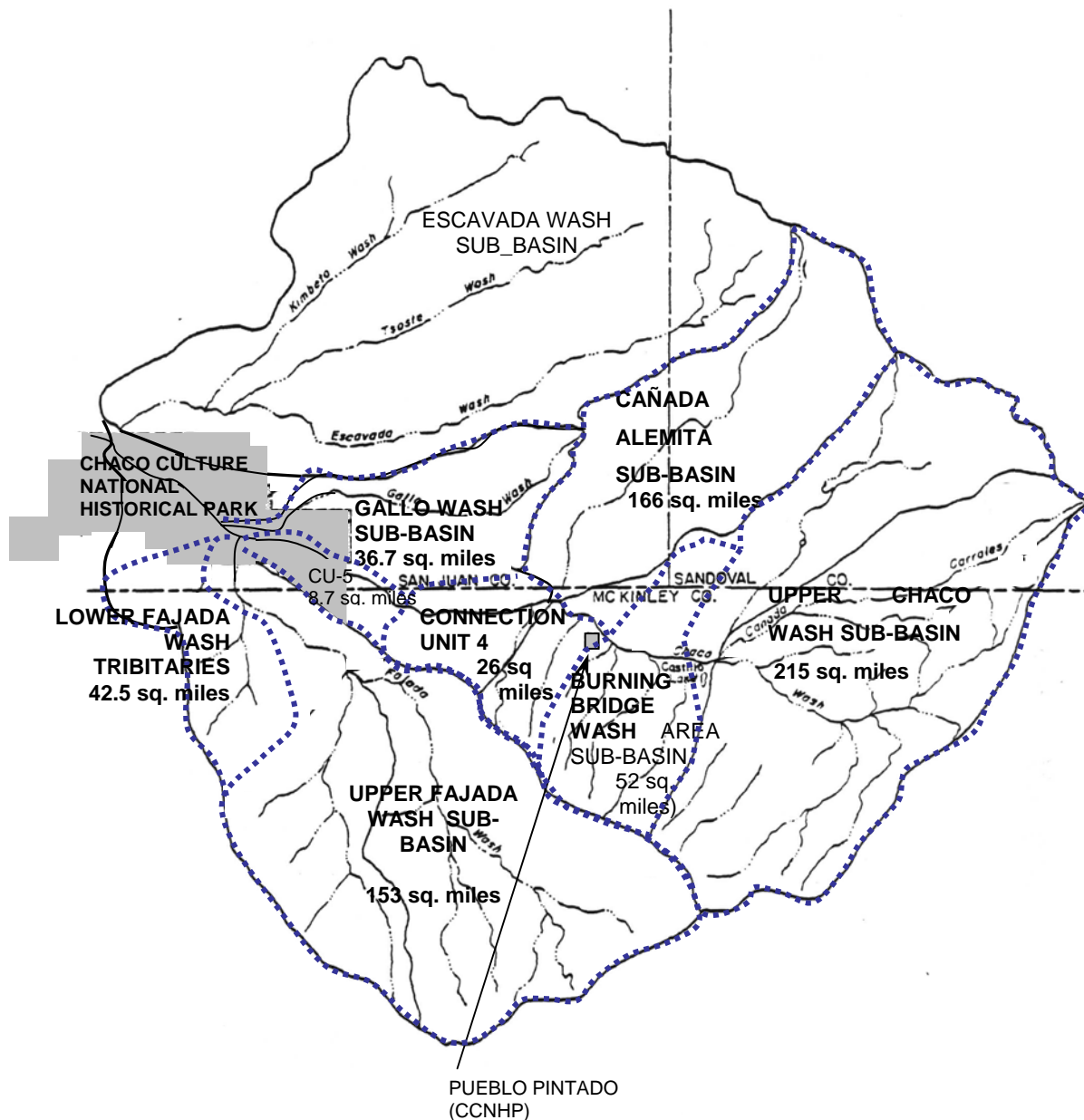
Revised 08/22/04

## PUEBLO del ARROYO EROSION CONTROL PROJECT SITE AREA DETAIL

Chaco Culture National Historical Park, New Mexico

FIGURE 1-2

NORTH



#### LEGEND

--- Chaco Wash Watershed Sub-Basins (Connection Units) as defined in Simons et al., 1982

#### SCALE

0 6  
One inch = approx. 6 miles

Map adapted from: Simons, Li, and Associates, Inc., (1982). Erosion Study at Chaco Culture National Historical Park, New Mexico.

### CHACO WASH DRAINAGE BASIN MAP

PUEBLO del ARROYO EROSION CONTROL PROJECT  
ENVIRONMENTAL ASSESSMENT  
Chaco Culture National Historical Park, New Mexico

FIGURE 1-3



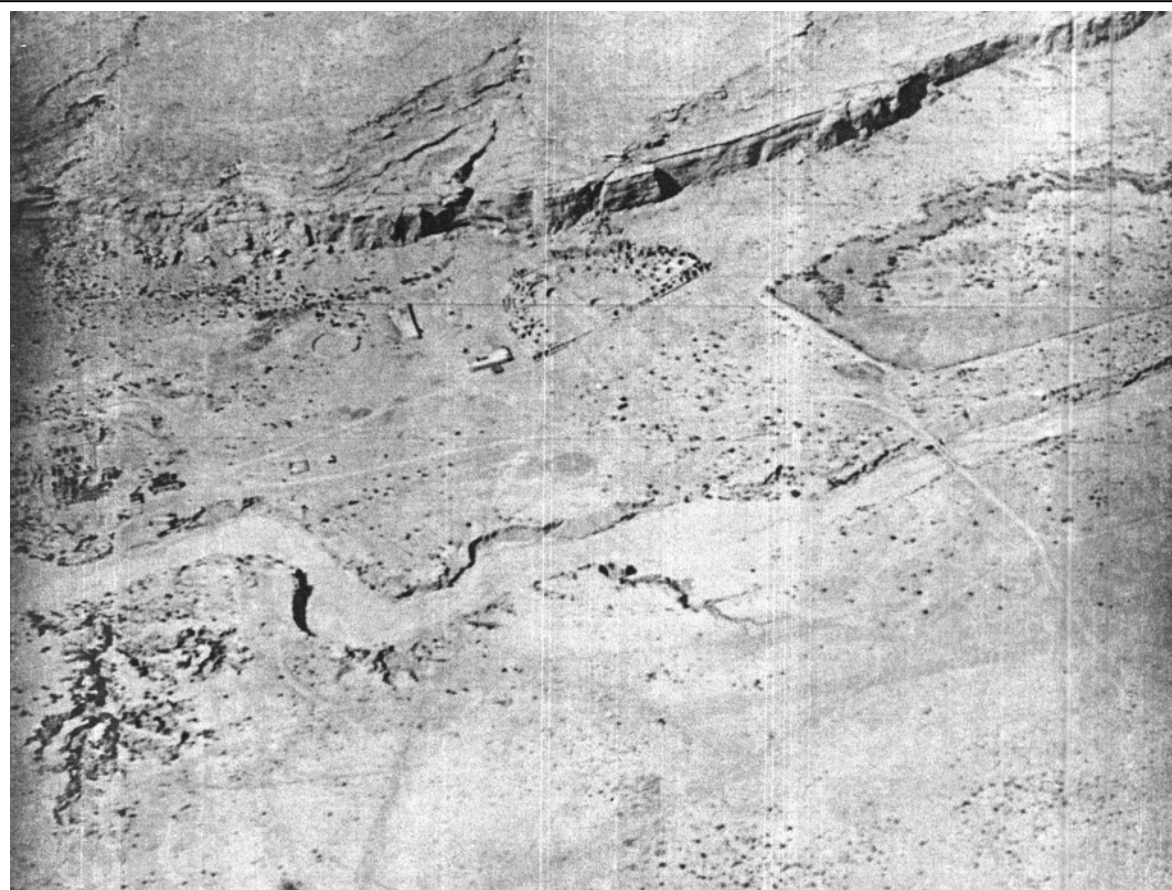


This photograph was taken at a point approximately 1000 feet downstream from Pueblo del Arroyo. The tendency for the arroyo walls, where vertical, to become undercut when in contact with flowing water is illustrated. The large piles of soil apparently have collapsed from the arroyo wall after it became undercut sufficiently.

**ARROYO WALL ILLUSTRATING EFFECTS of UNDERCUTTING**

**PUEBLO del ARROYO EROSION CONTROL PROJECT  
ENVIRONMENTAL ASSESSMENT  
Chaco Culture National Historical Park, New Mexico**

**PHOTOGRAPH 3**



Aerial Photograph taken in 1929 (Charles Lindbergh) of the Pueblo Bonito-Pueblo del Arroyo area of Chaco Canyon. Oblique view is to the northeast. Pueblo del Arroyo is at the extreme left of the photo. The braided, un-vegetated sandy arroyo floor present at that time is displayed prominently.

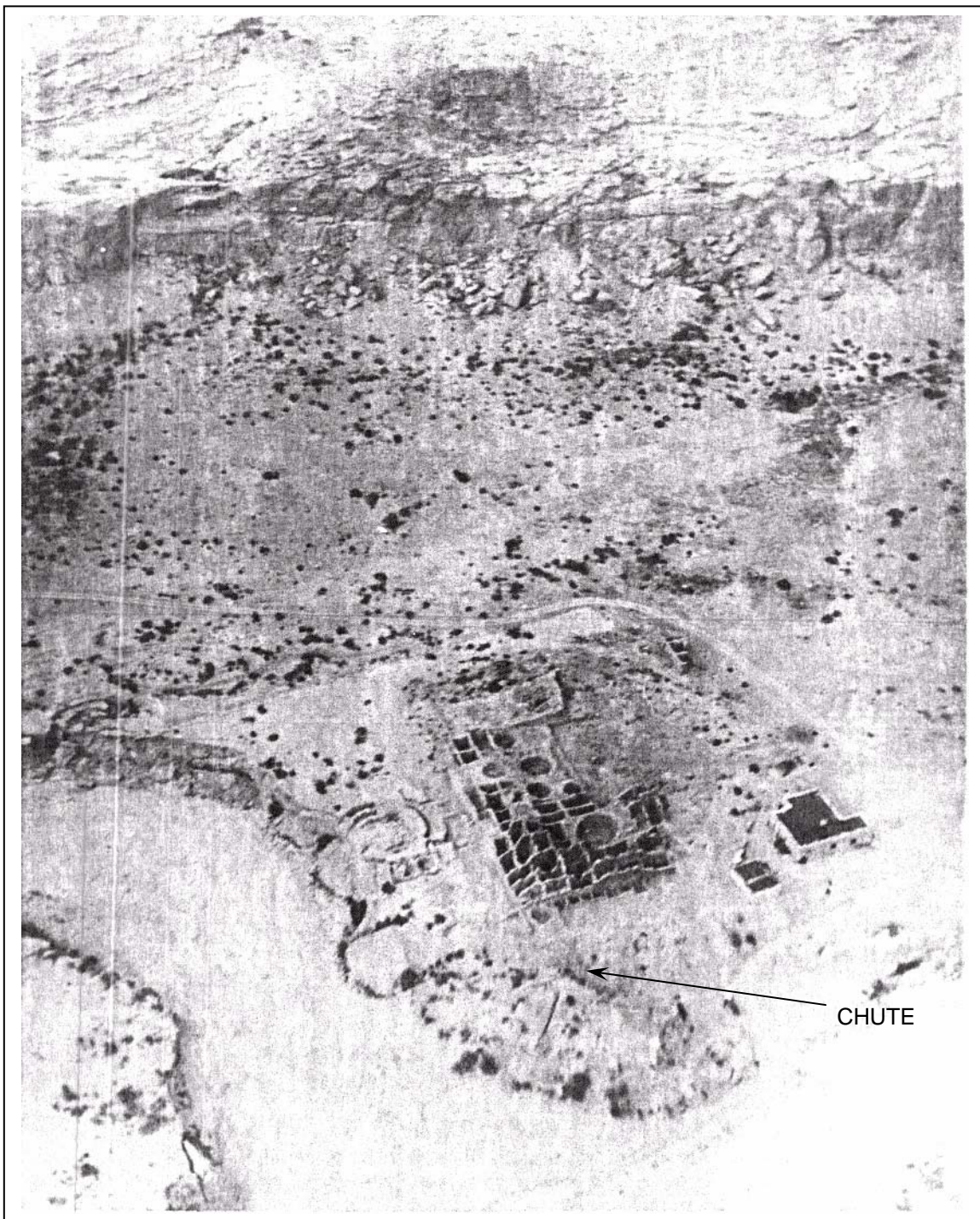
Source: Lindbergh, C., 1929. Courtesy: Laboratory of Archaeology, University of New Mexico.

#### **HISTORICAL AERIAL PHOTO NO. 1**

**PUEBLO del ARROYO EROSION CONTROL PROJECT  
ENVIRONMENTAL ASSESSMENT  
Chaco Culture National Historical Park, New Mexico**

**FIGURE 1-4**





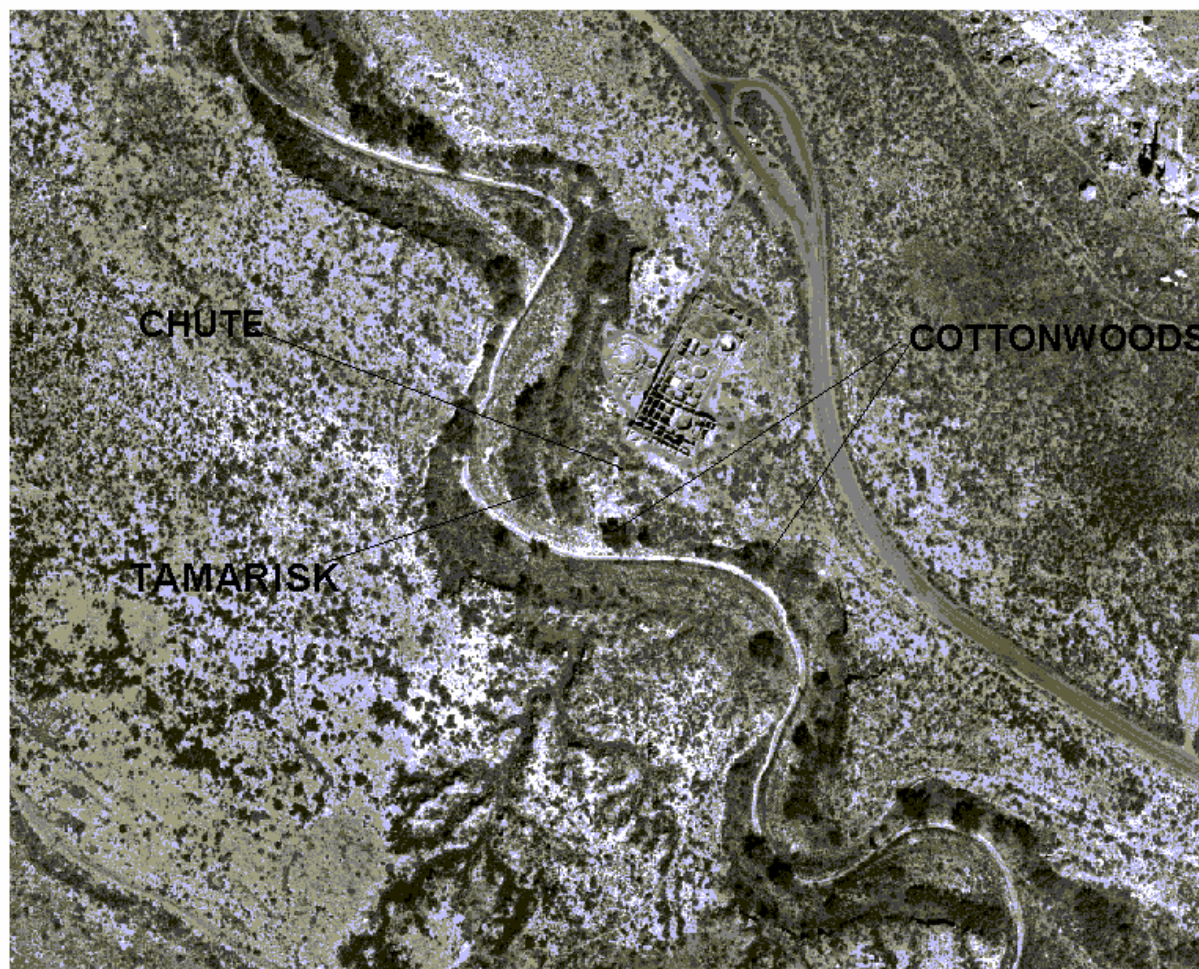
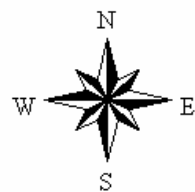
Aerial photograph taken in 1929 (Charles Lindbergh) of the Pueblo del Arroyo site. The oblique view is to the northeast. The chute and adjacent soil "island" is visible. A few small shrubs are visible on the north slope of the chute. The nearly-vertical straight line feature just below the ruins is located on the top surface of the "island". The Trading Post Building and access road into the arroyo are observable, as is the flat, un-vegetated arroyo floor.

Source: Charles Lindbergh, 1929. *Courtesy* Laboratory of Archaeology, University of New Mexico.

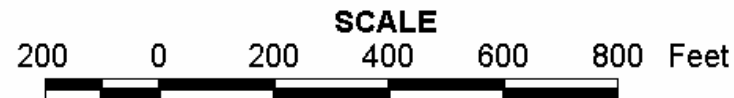
**HISTORICAL AERIAL PHOTOGRAPH NO. 2**  
**PUEBLO del ARROYO EROSION CONTROL PROJECT**  
**ENVIRONMENTAL ASSESSMENT**  
**Chaco Culture National Historical Park, New Mexico**

**FIGURE 1-5**





Aerial Photograph taken in 2000. The inner channel is well-defined and grass cover is present over most of the arroyo floor. Cottonwood tree clusters and tamarisk thickets are also visible. Relatively few trees are present in the area immediately south of PDA, in the embayed area at the upstream end of the chute. Source: Chaco Culture National Historical Park



**PRESENT-DAY (2000) AERIAL PHOTOGRAPH  
PUEBLO del ARROYO EROSION CONTROL PROJECT  
ENVIRONMENTAL ASSESSMENT  
Chaco Culture National Historical Park, New Mexico**

**FIGURE 1-6**





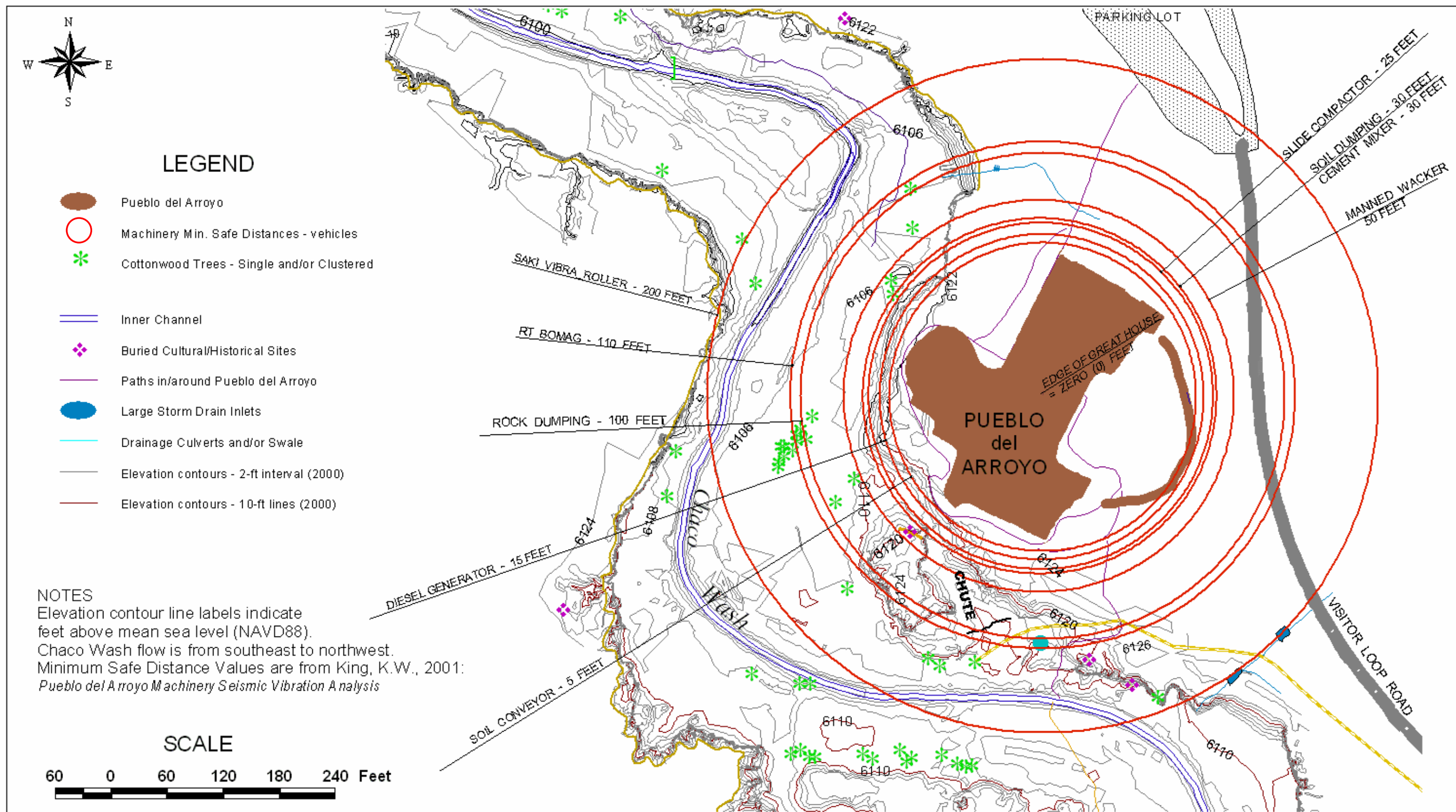
View to the southwest from Pueblo Bonito overlook. The trailhead for the overlook trail is  $\frac{3}{4}$  mile west from this point. This view illustrates Pueblo del Arroyo's location in the middle of the canyon floor, adjacent to the arroyo. The cut-off chute is visible just to the left of Pueblo del Arroyo. *Photo Credit: Tom Ricketts*

**PUEBLO del ARROYO – PUEBLO BONITO OVERLOOK VIEW**

**PUEBLO del ARROYO EROSION CONTROL PROJECT  
ENVIRONMENTAL ASSESSMENT  
Chaco Culture National Historical Park, New Mexico**

**PHOTOGRAPH 4**

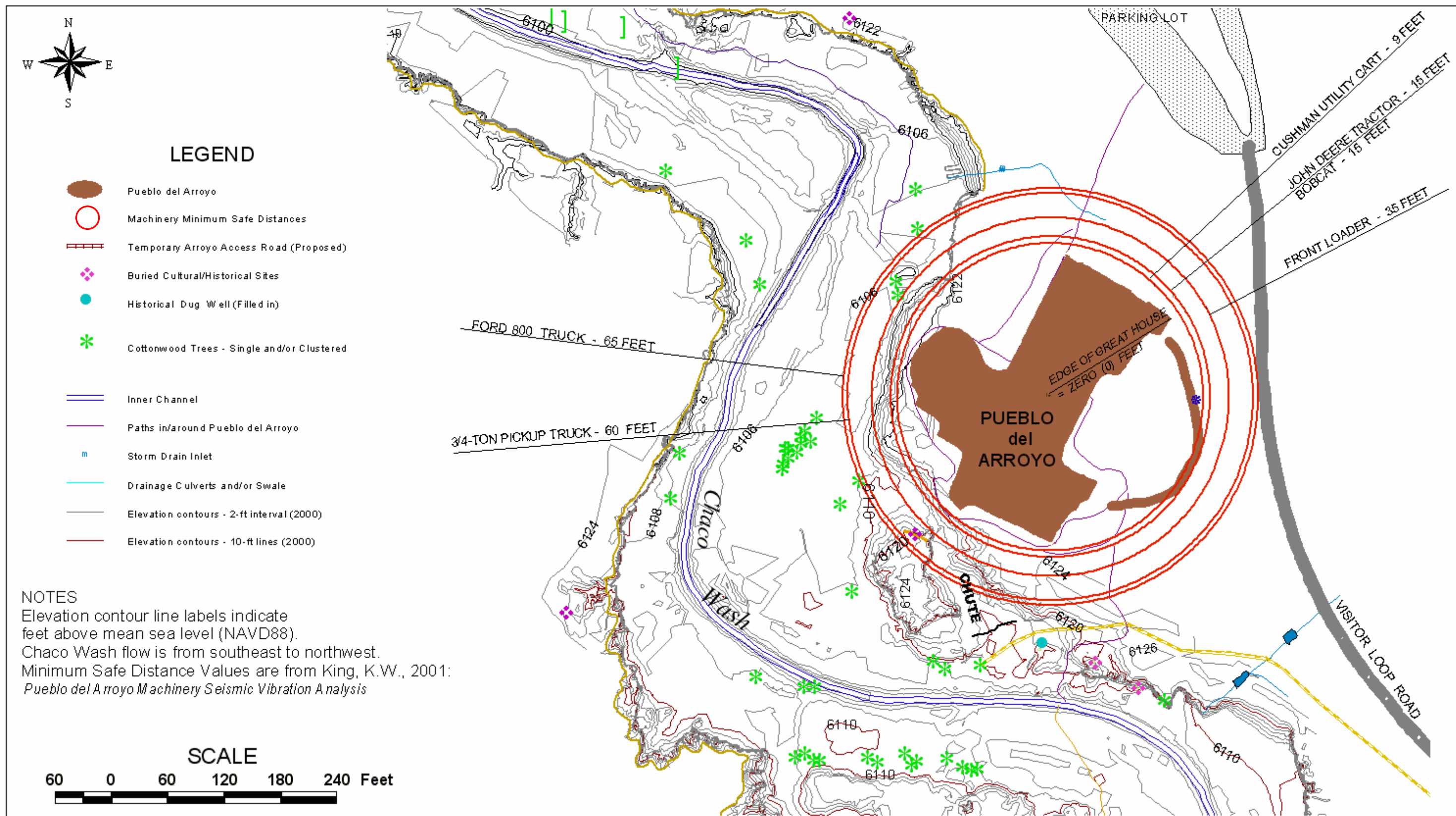




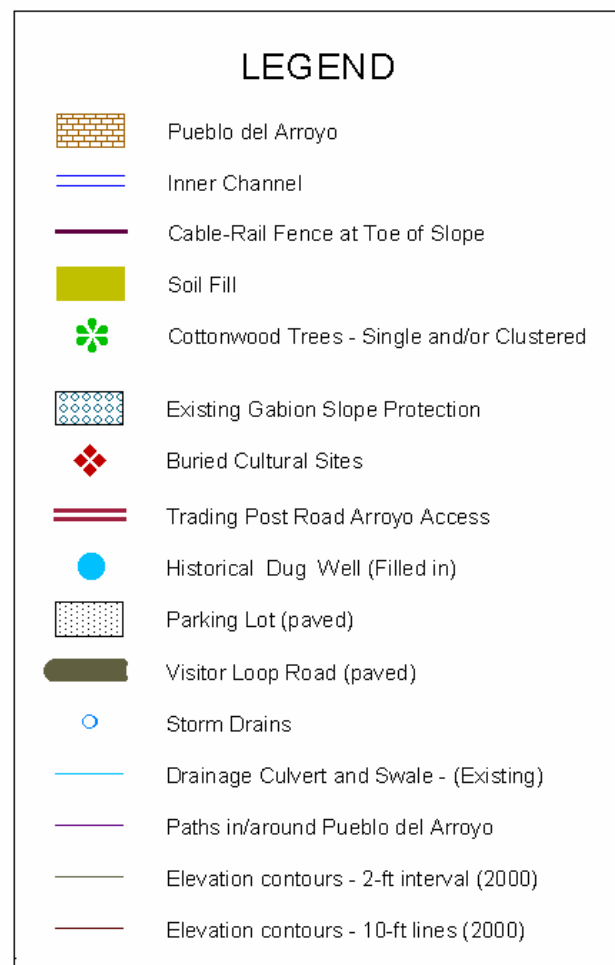
U.S. Department of the Interior  
 National Park Service  
 Revised 08/20/04

**VIBRATION ANALYSIS - MINIMUM SAFE DISTANCES  
 COMPACTORS/MISCELLANEOUS MACHINERY  
 PUEBLO del ARROYO EROSION CONTROL PROJECT  
 ENVIRONMENTAL ASSESSMENT  
 Chaco Culture National Historical Park**

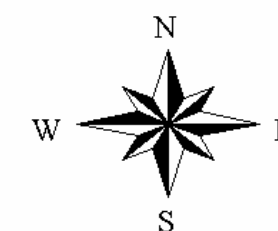
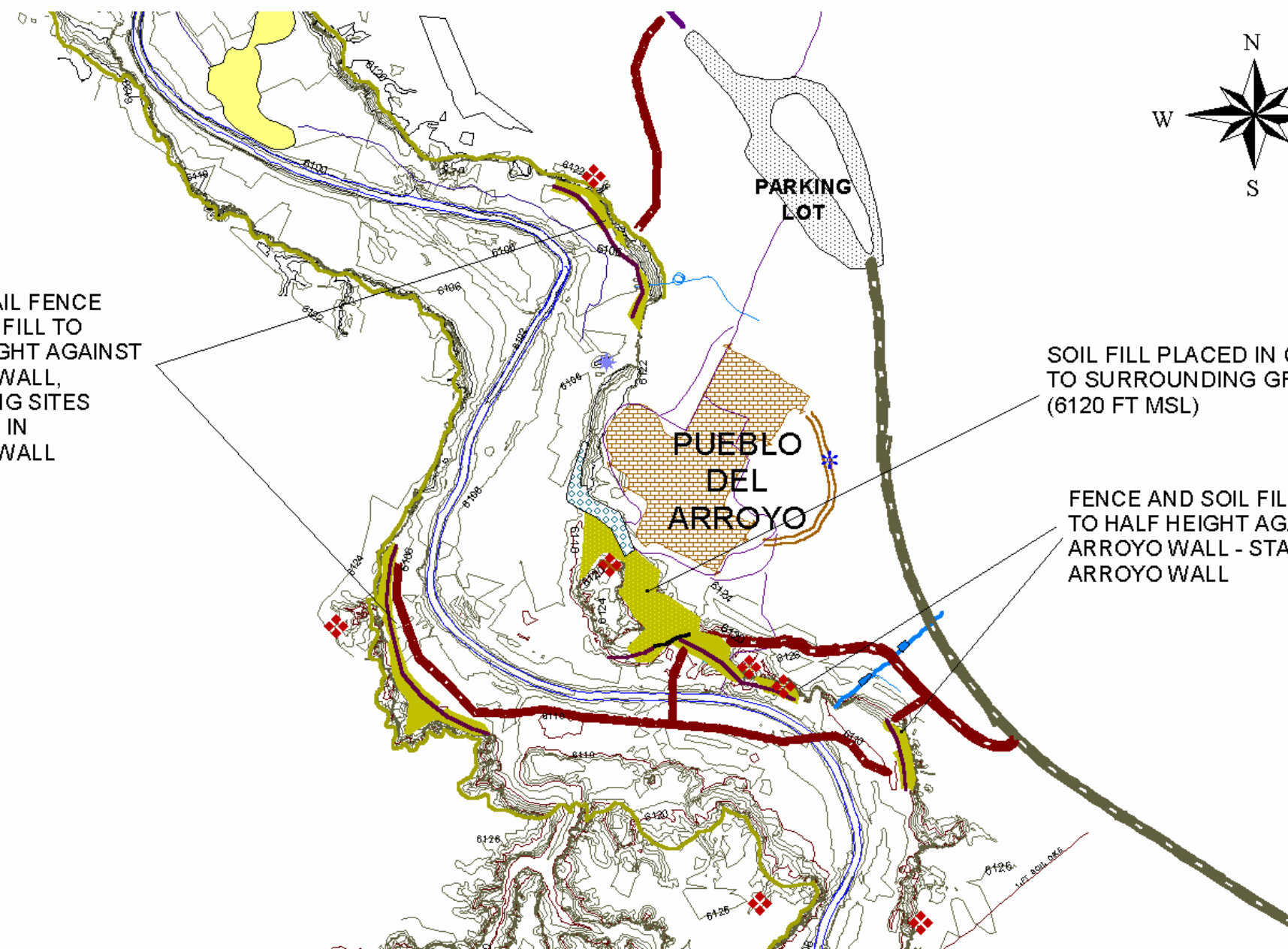
**FIGURE 1-7**







CABLE-RAIL FENCE AND SOIL FILL TO HALF-HEIGHT AGAINST ARROYO WALL, STABLIZING SITES EXPOSED IN ARROYO WALL



SOIL FILL PLACED IN CHUTE TO SURROUNDING GRADE (6120 FT MSL)

FENCE AND SOIL FILL TO HALF HEIGHT AGAINST ARROYO WALL - STABILIZES ARROYO WALL

SCALE

Note: Chaco Wash flow direction is from southeast to northwest.



U.S. Department of the Interior  
National Park Service  
Revised 08/22/04

**PUEBLO DEL ARROYO EROSION CONTROL PROJECT  
PREFERRED ALTERNATIVE (ALT. 2) FENCING AND SOIL FILL  
IN CHUTE AND ALONG ARROYO WALL TO HALF HEIGHT  
Chaco Culture National Historical Park, New Mexico**

**FIGURE 2-1**

LEGEND

Pueblo del Arroyo

Inner Channel

Jetties and Fencing - Proposed Alternative 3

Cottonwood Trees - Single and/or Clustered

Tamarisk thickets/patches

Tamarisk (individual)

Existing Gabion Slope Protection

Buried Cultural Sites

Paths in/around Pueblo del Arroyo

Parking Lot (paved)

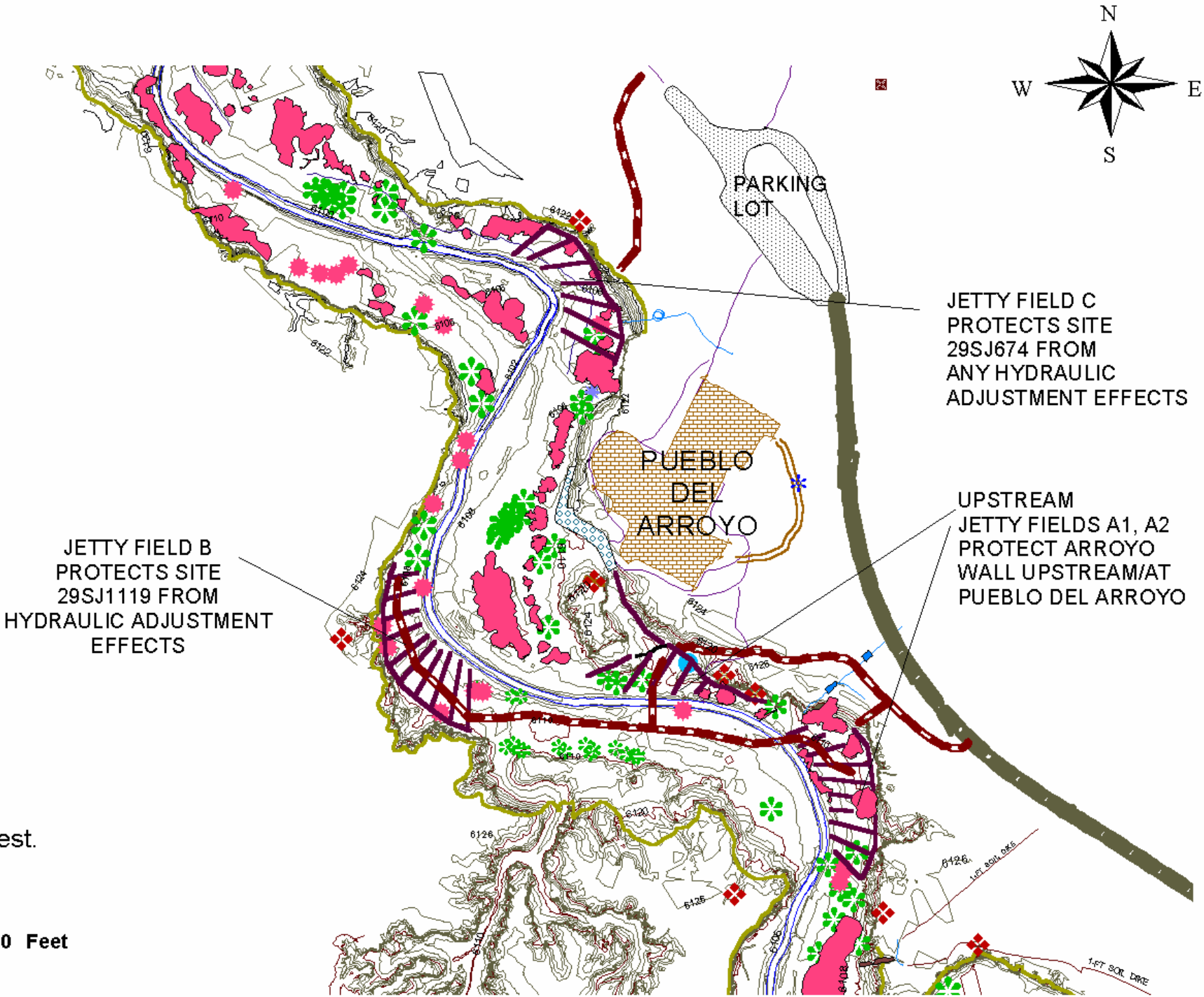
Visitor Loop Road (paved)

Culvert - Storm Drain SE of PDA

Storm Drains

Elevation contours - 2-ft interval (2000)

Elevation contours - 10-ft lines (2000)



Note: Chaco Wash flow direction is from southeast to northwest.



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National Park Service  
Revised 08/23/04

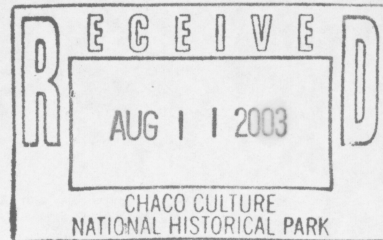
**PUEBLO DEL ARROYO EROSION CONTROL PROJECT  
PROPOSED ALTERNATIVE 3  
JETTIES AND FENCING  
Chaco Culture National Historical Park**

FIGURE 2-2

# United States Department of the Interior



NATIONAL PARK SERVICE  
Chaco Culture National Historical Park  
Post Office Box 220  
Nageezi, New Mexico 87037-0220

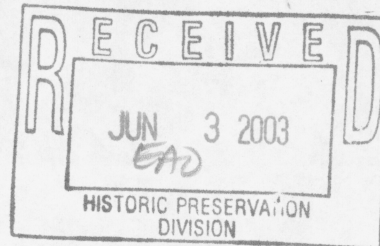


068027

IN REPLY REFER TO:

H2215

Elizabeth Oster  
Staff Archeologist  
Historic Preservation Division  
228 East Palace Avenue  
Santa Fe, New Mexico 87501



May 22, 2003

Dear Ms. Oster:

Enclosed is a document that considers the effects to listed properties by the preferred alternative in the Pueblo del Arroyo Erosion Control Project environmental assessment. Normally, the park would use an environmental screening form to evaluate the effects of the proposed action, but the enclosed narrative document provides a better format for incorporating the review into the draft environmental assessment. A contractor is developing the overall environmental assessment, but they lacked the Chaco- specific cultural resource expertise to do this evaluation.

The park selected this preferred erosion control alternative because it provides the greatest protection for Pueblo del Arroyo in the event of a '100-year' flood event while maintaining the cultural landscape in the Chaco Core and limiting impacts to other eligible properties within the area of potential effect. Other alternatives would either have an adverse effect on both the cultural landscape and surrounding eligible properties or provide only minimal flood protection to Pueblo del Arroyo.

We have determined that this preferred alternative will have no adverse effect on the known listed properties surrounding and including Pueblo del Arroyo, nor on the cultural landscape of the Chaco Core.

If you have questions or need further information, please contact Dabney Ford at 505 786-7014 ext. 242.

Sincerely,

Stephanie Dubois  
Superintendent

The park is to be commended for taking a proactive approach to this significant problem.

Concurrence by New Mexico State Historic Preservation Office

Comments/Stipulations:

8/1/2003  
Date

"No adverse effect," subject to some stipulations: LA Site Update forms should be filled out for previously recorded sites in the APE with the exception of Pueblo del Arroyo, which has been thoroughly documented by other means. Also, the Historic Rubble Dump should now be recorded as a site and its eligibility assessed. A report detailing the results of the testing should be prepared and submitted for review. The park will doubtless consult with tribes regarding this undertaking; please forward the results of consultation for inclusion in the file.





STATE OF NEW MEXICO  
**DEPARTMENT OF CULTURAL AFFAIRS**  
**HISTORIC PRESERVATION DIVISION**

228 EAST PALACE AVENUE  
SANTA FE, NEW MEXICO 87501  
(505) 827-6320

BILL RICHARDSON

Governor

Stephanie Dubois, Superintendent  
Chaco Culture National Historic Park  
PO Box 220  
Nageezi, NM 87037-0020

9 February 2005

Re: Pueblo del Arroyo Erosion Control Project,  
NEPA/106 Review

Dear Ms. Dubois:

I am writing to acknowledge consultation with your cultural resources management staff and the receipt of written documentation regarding proposed changes to the Pueblo del Arroyo Erosion Control Project.

Formal documentation of the proposed changes was faxed to this office on 14 January 2005 and received in the mail on 25 January 2005 (HPD Log # 73359). I spoke with Roger Moore of your staff on 21 January 2005 and discussed the proposed changes, with which this office is essentially in agreement.

This office was informally contacted regarding this undertaking in the spring of 2003. A request for formal concurrence with a determination of "no adverse effect" (subject to stipulations) with Preferred Alternative #5 (Combination CableRail Jetty, Soil Fill, and Vegetation) was received on 3 June 2003 (HPD Log # 68027; see enclosed) and signed on behalf of the NM SHPO on 9 August 2003. This alternative was apparently re-described in park planning documents as Alternative 2 in January of 2004, but the essential project elements were unchanged (see the compliance documents for full descriptions of the various alternatives). While some sites within the APE would be covered with soil fill as a result of the proposed work, the park and this office concurred that the long-term benefits to these and other sites in the APE threatened by erosion outweighed the potential effects to a small subset of sites. Further, the effects of soil fill on a subset of sites would not be adverse. Temporary access was to be provided by using an abandoned historic road that proceeds along the arroyo floor from Pueblo Bonito.

The stipulations cited in the 2003 concurrence documentation included the following:

- Laboratory of Anthropology Site Update forms were to be filled out for previously recorded sites in the APE (LA 40675, LA 40823, LA 40674, LA 41119, LA 41353,

LA 41354) with the exception of Pueblo del Arroyo (LA 41947), which has been documented by other means;

- The Historic Rubble Dump was to be recorded as a site and assessed for eligibility to the National Register;
- A report detailing the testing results was to be prepared and submitted for review by this office;
- The reports of tribal consultation conducted for the undertaking were to be forwarded to this office.

As time has passed and the target date for finalizing the Environmental Assessment and initiating the fieldwork has approached, park cultural resources management staff have made revisions to the project plans in order to address concerns and comments from the Park's management team. At this juncture, park staff have determined that it would be preferable to use the old trading post road to provide access into the arroyo at the southeast corner of Pueblo del Arroyo. This determination is based on the realization that with the deletion of two impracticable alternatives from consideration in the environmental analysis (the Revetment Alternative and the Vegetation Alternative; these alternatives actually involved the most intensive disturbance), use of the road along the arroyo floor from Pueblo Bonito would be unnecessary and would have required substantial extra travel by vehicles associated with the project work as well as construction of an extension. Use of the trading post road will involve less vehicle traffic and will allow a soil conveyor to be used to transport fill to one of the target locations, obviating the need for an extension of the arroyo road. With respect to the potential for impacts associated with noise and vibration emanating from heavy machinery, the trading post road now proposed for use lies at a safe distance from Pueblo del Arroyo (very large machinery for which the minimum "safe distance" from structures exceeds the distance between Pueblo del Arroyo and the trading post road will not be used). An additional temporary road will be constructed at one location, to provide access for the northwest end of the parking lot to the vicinity of LA 40674 (29SJ 674).

This office concurs that the proposed modifications to the preferred alternative as it was originally consulted upon are the products of reasoned decisions made with full knowledge of and consideration of potential effects to eligible historic properties. The undertaking as originally planned and now modified constitutes a very pro-active approach to a pervasive source of long-term adverse effects to world-class historic properties. At this juncture, the only additional item I would propose for consideration in terms of effects is the trading post road itself. This road, too, is part of Chaco Canyon's history of human use. The proposed action makes use of the road as access, thus it is once again fulfilling its historic function. The sizes of the equipment proposed for use (bobcats, front-end loaders, and presumably light trucks and dump trucks) should not cause adverse effects to the road for the limited period that it will be in use, but the road should be recorded as a linear historic site or feature. I would suggest filling out a Laboratory of Anthropology form for the road, evaluating it for eligibility, and submitting the form with photographs for archiving at the Archaeological Records Management

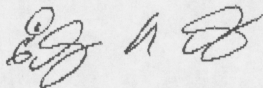


Section. Perhaps this work could be performed in conjunction with recordation of the Historic Rubble Mound.

In conclusion, this office concurs that the original determination of "no adverse effect" to properties listed on, or eligible to, the National Register of Historic Places stands for the undertaking as now proposed. We request that the original stipulations be adhered to, with the addition of recordation of the trading post road.

Please contact me at (505) 827-6315 if I can be of any further assistance. Best of luck as you move forward—these are exciting times at Chaco.

Sincerely,

A handwritten signature in dark ink, appearing to read 'E. A. Oster', written in a cursive style.

Elizabeth A. Oster  
Archaeologist  
Log: 73359; 68027